OFFICE OF NAVAL INTELLIGENCE.

General Information Series, No. XX.

INFORMATION FROM ABROAD.

64257

NOTES

ON

NAVAL PROGRESS.

JULY, 1901.

DEPARTMENT OF THE NAVY
BUREAU OF NAVIGATION

OFFICE OF NAVAL INTELLIGENCE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

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INTRODUCTION.

This number of Notes on Naval Progress includes the principal features of general naval interest which have been compiled since July 1, 1900.

The question of sheathing ships having been much discussed during the past year, some foreign practice in regard to sheathing is given. There are presented some excellent records made in coaling foreign ships, and some interesting results of the special training of gun pointers. The discussion of water-tube boilers now in progress in England is referred to, with the conclusions reached. Under wireless telegraphy the tuned and the multiplex systems are discussed and the increase in range is given. Certain European nations, alive to the necessity for sea power, have been greatly assisted in securing naval appropriations through the work of navy leagues. The efforts of these societies in certain countries have been rewarded by large and steady increase in naval strength. Systems of navy leagues are described. An article on the transportation of the German expeditionary force to China is given. Also graphic tables which show the naval strength of nations compared with the interests which they are expected to protect.

C. D. Sigsbee,
Captain, U. S. N., Chief Intelligence Officer.

Navy Department, *July 1, 1901.*

Approved.
A. S. Crowninshield,
Chief of Bureau of Navigation.

I.

NOTES ON SHIPS AND TORPEDO BOATS.

By Lieutenant Harry Phelps, United States Navy,
Staff Intelligence Officer.

Section I.

BUILDING, ORDERED, AND PROPOSED.

CONSTRUCTION ABROAD.

The various powers continue active in building up their fleets, and the budgets show that there will be no relaxation in the coming year. A large number of vessels have been launched, and many have had their trials.

The list of ships laid down contains all ships that are known to have been laid down, but there are many others that have been authorized and ordered and probably laid down, though information to that effect has not yet reached this Office.

There has been no marked change in designs of ships. Proposed changes in armament are the putting of 11-in. R. F. guns on board the new German battleships, and twelve 8-in. R. F. guns on board each of the new Italian battleships.

The reconstruction of the German ships of the *Siegfried* class is going on, and all these vessels will be quite up to date when completed, and their efficiency much increased.

The subject of submarine boats has been much discussed, and England is about to acquire five of this type of vessel. France is already committed to their use by planning some forty-two, built, building, or proposed. Germany has had the subject under discussion, but the latest report is that their efficiency is not yet proved, and that the Government will await further developments before taking action. Italy is about to resume experiments with the *Delfino*, a submarine boat of about 107 tons, built in 1896, and, it is reported, has ordered twenty new ones built, while the Norwegian Government proposes to add six of these boats to the fleet and has ordered built one of about 120 tons. A design of a submarine boat of about 145 tons is under consideration by the Swedish Government, and it is reported that an electrically propelled submarine boat is building for the Russian Government.

Ships Laid Down since Last Report.

AUSTRIA.

Name.	Class.	Tonnage.	Place.	Date:
"E"	Armored cruiser	7,300	Trieste	Nov. —, 1900

DENMARK.

"A"	Battleship, third class	5,000	Copenhagen	—— —, 1901

ENGLAND.

Prince of Wales	Battleship, first class	15,000	Chatham	Mar. 20, 1901
Queen	do	15,000	Devonport	Mar. 12, 1901
Bedford	Armored cruiser	9,800	Glasgow	Feb. 19, 1900
Berwick	do	9,800	do	—— —, 1901
Cornwall	do	9,800	Pembroke	Mar. 11, 1901
Cumberland	do	9,800	Glasgow	Feb. 19, 1901
Donegal	do	9,800	do	Feb. 14, 1901
Lancaster	do	9,800	Elswick	—— —, 1901
Suffolk	do	9,800	Portsmouth	Mar. 25, 1901
Challenger	Protected cruiser, second class	5,880	Chatham	Dec. 1, 1900
Encounter	do	5,880	Devonport	Jan. 28, 1901
Merlin	Sloop	1,100	Sheerness	Feb. 11, 1901
Odin	do	1,100	do	Do.
Moorhen	Shallow-draught gunboat	180	Poplar	—— —, 1901
Teal	do	180	do	—— —, 1901

FRANCE.

Condé	Armored cruiser	10,000	Lorient	Apr. 1, 1901
Jules Ferry	do	12,550	Cherbourg	
Léon Gambetta	do	12,550	Brest	
Arbalète	Torpedo-boat destroyer	303	Havre	
Arquebuse	do	303	do	
Carabine	do	303	Rochefort	
Flamberge	do	303	do	Jan. 2, 1901
Rapière	do	303	do	Do.
Sarbacane	do	303	do	
Espadon	Submarine	185	Cherbourg	
Farfadet	do	185	Rochefort	Apr 2, 1900
Gnome	do	185	do	
Korrigan	do	185	do	Apr. 23, 1900
Lutin	do	185	do	
Silure	do	106	Cherbourg	
Sirène	do	106	do	Aug. 28, 1900
Triton	do	106	do	Do.
"143"	Torpedo boat	80	Toulon	Jan. 2, 1901
"223"	do	84	Cherbourg	Sept. 3, 1900
246 to 251	do	91	Private yards	
253 to 265	do	91	do	

Ships laid down since last report—Continued.

GERMANY.

Name.	Class.	Tonnage.	Place.	Date.
"G"	Battleship, first class	11,800	Wilhelmshaven	Oct. 18, 1900
Prinz Adalbert	Armored cruiser	8,870	Kiel	July 5, 1900
Panther	Gunboat	900	Danzig	July 16, 1900

HOLLAND.

De Ruyter	Battleship, third class	4,870	Rotterdam	May 12, 1900
Hertog Hendrik	....do	4,870	Amsterdam	Oct. 13, 1900
Pangrango	Torpedo boat, first class	115	Poplar	—— —, 1900
Rindjani	....do	115	....do	—— —, 1900

RUSSIA.

Borodino	Battleship, first class	13,600	St. Petersburg	May 25, 1900
Imperator Alexander III.	....do	13,600	....do	Do.
Orel	....do	13,600	....do	June 11, 1900
Admiral Butakoff.	Coast-defense ironclad	6,000	....do	—— —, 1900
Vityas	Protected cruiser, first class	6,300	....do	Nov. 3, 1900
Boyarin	Protected cruiser, second class	3,200	Copenhagen	Dec. 21, 1899
Okean	Training transport	12,000	Kiel	June 1, 1901
Kefal	Torpedo-boat destroyer	312	Havre	—— —, 1900
Losos	....do	312	....do	—— —, 1900

SHIPS LAUNCHED SINCE LAST REPORT.

AUSTRIA.

Name.	Class.	Tonnage.	Built at—	Laid down.	Launched.
Habsburg	Battleship, first-class	8,340	Trieste	Mar. —, 1899	Sept. 9, 1900
Szigetvar	Cruiser, third-class	2,400	Pola	May —, 1899	Oct. 29, 1900

DENMARK.

Beskytteren	Torpedo transport	390	Copenhagen	Nov. 23, 1899	June 7, 1900

ENGLAND.

Albemarle	Battleship, first-class	14,000	Chatham	Jan. 8, 1900	Mar. 5, 1901
Duncan	....do	14,000	Blackwall	July 10, 1899	Mar. 21, 1901
Montagu	....do	14,000	Devonport	Nov. 23, 1899	Mar. 5, 1901
Russell	....do	14,000	Jarrow	Mar. 11, 1899	Feb. 19, 1901
Bacchante	Armored cruiser	12,000	Glasgow	Feb. 15, 1899	Feb. 21, 1901
Drake	....do	14,100	Pembroke	Apr. 24, 1899	Mar. 5, 1901
Euryalus	....do	12,000	Barrow	July 18, 1899	May 20, 1901
Good Hope	....do	14,100	Glasgow	Sept. 11, 1899	Feb. 21, 1901
Hogue	....do	12,000	Barrow	July 14, 1898	Aug. 13, 1900
Kent	....do	9,800	Portsmouth	Feb. 12, 1900	Mar. 6, 1901
Leviathan	....do	14,100	Glasgow	Nov. 30, 1899	July 3, 190

Ships launched since last report—Continued.

ENGLAND—Continued.

Name.	Class.	Tonnage.	Built at—	Laid down.	Launched.
Espiègle	Sloop	1,070	Sheerness	Jan. 8, 1900	Dec. 8, 1900
Fantome	do	1,070	do	do	Mar. 23, 1901
Rinaldo	do	980	Birkenhead	Nov. 8, 1898	May 28, 1900
Teal	Shallow-draught gunboat.	180	Poplar	—— —, 1901	May 18, 1901
Cobra	Torpedo-boat destroyer.	410	Newcastle	—— —, 1899	—— —, 1900
Greyhound	do	360	do	—— —, 1899	Oct. 6, 1900
Kangaroo	do	370	Jarrow	—— —, 1899	Sept. 8, 1900
Lively	do	360	Birkenhead	—— —, 1899	July 14, 1900
Racehorse	do	360	Newcastle	—— —, 1899	Nov. 8, 1900
Roebuck	do	360	do	—— —, 1899	Jan. 4, 1901
Sprightly	do	360	Birkenhead	—— —, 1899	Sept. 25, 1900
Syren	do	370	Jarrow	—— —, 1899	Dec. 20, 1900
Thorn	do	383	Glasgow	—— —, 1899	Mar. 17, 1900
Tiger	do	383	do	—— —, 1899	May 19, 1900
Vigilant	do	383	do	—— —, 1899	Aug. 16, 1900
Vixen	do	370	Barrow	—— —, 1899	Mar. 29, 1900
No. 98	Torpedo boat	150	Chiswick	—— —, 1900	Jan. 22, 1901
No. 99	do	150	do	—— —, 1900	Mar. 5, 1901
No. 107	do	150	do	—— —, 1900	July 2, 1901

FRANCE.

Desaix	Armored cruiser	7,700	Lorient	—— —, 1899	Mar. 21, 1901
Dupetit-Thouars	do	9,500	Toulon	Apr. 17, 1899	July 5, 1901
Marseillaise	do	10,000	Brest	Jan. 10, 1900	July 14, 1900
Sully	do	10,000	La Seyne	June —, 1900	June 4, 1901
Vaucluse	Dispatch transport	1,600	Rochefort	May 1, 1886	Apr. 17, 1901
Épée	Torpedo-boat destroyer.	311	Havre	—— —, 1899	July 27, 1900
Escopette	do	303	Rochefort	Apr. —, 1900	Dec. 20, 1900
Espignole	do	303	Havre	—— —, 1899	June 28, 1900
Pertuisane	do	303	Rochefort	Apr. —, 1900	Dec. 5, 1900
Audacieux	Torpedo boat	180	Nantes	—— —, 1899	Aug. 29, 1900
Borée	do	160	Bordeaux	Apr. 20, 1900	Mar. 23, 1901
Mistral	do	180	Havre	—— —, 1900	May 4, 1901
Simoun	do	180	do	—— —, 1900	Mar. 23, 1901
Sirocco	do	180	do	—— —, 1900	Feb. 20, 1901
Tramontane	do	160	Bordeaux	Apr. 20, 1900	May 21, 1901
Trombe	do	180	Nantes	—— —, 1899	July 28, 1900
Typhon	do	180	Havre	—— —, 1900	June 15, 1901
No. 242	do	90	Saigon	—— —, 1900	Apr. 20, 1901
No. 243	do	90	Havre	—— —, 1899	July 16, 1900
No. 252	do	90	Nantes	—— —, 1899	June 30, 1900
Algerien	Submarine	146	Cherbourg	Oct. 3, 1899	Apr. 27, 1901
Farfadet	do	185	Rochefort	Apr. 2, 1900	May 17, 1901
Français	do	146	Cherbourg	—— —, 1900	Jan. 29, 1901
Sirène	do	106	do	Aug. 28, 1900	May 4, 1901

Ships launched since last report—Continued.

GERMANY.

Name.	Class.	Tonnage.	Built at—	Laid down.	Launched.
Wettin	Battleship, first-class	11,800	Danzig	Oct. 10, 1899	June 6, 1901
Wittelsbach	do	11,800	Wilhelmshaven	Sept. 30, 1899	July 3, 1900
Zaehringen	do	11,800	Kiel	Nov. 21, 1899	June 12, 1901
Prinz Adalbert	Armored cruiser	8,870	do	July 5, 1900	June 22, 1901
Amazone	Protected cruiser, third-class.	2,800	do	Dec. 1, 1899	Oct. 6, 1900
Ariadne	do	2,800	Bremen	Dec. 14, 1899	Aug. 10, 1900
Medusa	do	2,800	do	June 22, 1900	Dec. 5, 1900
Thetis	do	2,800	Danzig	Sept. 2, 1899	July 3, 1900
Panther	Gunboat	900	do	July 16, 1900	Apr. 1, 1901
S-98	Torpedo-boat destroyer.	350	Elbing	Nov. 7, 1899	July 28, 1900
S-99	do	350	do	Feb. 12, 1900	Sept. 4, 1900
S-100	do	350	do	—— —, 1900	Nov. 13, 1900
S-101	do	350	do	—— —, 1900	Dec. 22, 1900
S-102	do	350	do	—— —, 1900	Apr. 18, 1901
S-103	do	350	do	—— —, 1900	May 15, 1901
S-104	do	350	do	—— —, 1900	June 22, 1901

HOLLAND.

Koningin Regentes.	Battleship, third-class	4,870	Amsterdam	Dec. 3, 1898	Apr. 24, 1900
Ophir	Torpedo boat	115	Poplar	—— —, 1900	Mar. 6, 1901
Pangrango	do	115	do	—— —, 1900	Apr. 17, 1901
Rindjani	do	115	do	—— —, ——	July 2, 1901

ITALY.

Regina Margherita	Battleship, first-class	13,500	Spezia	Nov. 20, 1898	May 30, 1901
Dardo	Torpedo-boat destroyer.	320	Elbing	Feb. 7, 1900	Aug. —, 1900
Euro	do	320	do	Jan. 9, 1900	Aug. 27, 1900
Lampo	do	320	do	Oct. 7, 1899	May —, 1900
Nembo	do	320	Naples	—— —, 1900	May 18, 1901
Ostro	do	320	Elbing	—— —, 1900	Feb. 9, 1901
Strale	do	320	do	Nov. 18, 1899	May 18, 1900

JAPAN.

Mikasa	Battleship, first-class	15,200	Barrow	Jan. 15, 1899	Nov. 8, 1900
Shirataka	Torpedo boat	120	Nagasaki		—— —, 1900
Nos. 37 and 38	do	82	do		—— —, 1900

RUSSIA.

Imperator Alexander III.	Battleship, first-class	13,600	St. Petersburg	May 25, 1900	Aug. 3, 1901
Kniaz Potemkin Tavritcheski.	do	12,600	Nikolaief	Oct. 10, 1898	Oct. 9, 1900
Retwisan	do	12,700	Philadelphia	Nov. 5, 1898	Oct. 23, 1900
Tsarevitch	do	12,900	La Seyne	May 18, 1899	Feb. 23, 1901

Ships launched since last report—Continued.

RUSSIA.—Continued.

Name.	Class.	Tonnage.	Built at—	Laid down.	Launched.
Bayan	Armored cruiser	7,800	La Seyne	July 11, 1899	June 12, 1900
Bogatyr	do	6,500	Stettin	Dec. 22, 1899	Jan. 30, 1901
Boyarin	Protected cruiser, second-class.	3,200	Copenhagen	Dec. 21, 1899	June 8, 1901
Novik	do	3,200	Danzig	Aug. 12, 1899	Aug. 15, 1900
Astrabad	Gunboat	326	Nizhni Novgorod.	—— —, 1899	—— —, 1900
Baklan	Torpedo-boat destroyer.	350	St. Petersburg		July —, 1900
Filin	do	240	do		June 23, 1900
Forel	do	312	Havre	—— —, 1900	Dec. 8, 1900
Osetr	do	312	do	—— —, 1900	Jan. 23, 1901
Sova	do	240	St. Petersburg		July 7, 1900
Sterliade	do	312	Havre	—— —, 1900	Mar. 8, 1901
Voron	do	240	St. Petersburg		May —, 1900

SPAIN.

Cataluña	Armored cruiser	7,000	Cartagena	Jan. 23, 1890	Sept. 24, 1900

SWEDEN.

Dristigheten	Coast-defense ship	3,500	Gottenborg	Nov. 8, 1898	Apr. 30, 1900

AUSTRIA.

The additions to the Austrian navy proposed or already in hand are the following:

"E," an armored cruiser of 7,400 tons, which is to supersede the frigate *Radetsky*. She will be of the following dimensions: length, 384 feet; beam, 61 feet 7 inches; draught, 21 feet 4 inches. The protection will consist of a partial belt of a thickness of 8.6 inches and an armored deck. The turrets for the 9.4-in. guns will be 7.8 inches thick and the casemates 5 inches thick, all of Krupp armor. The armament will consist of two 9.4-in. guns in turrets forward and aft and ten 5.9-in. guns in casemates. There will be two triple-expansion engines of the combined power of 13,200 i. h. p., to give a speed of 21 knots. The boilers will be of the Yarrow type, the type Austria seems to have adopted.

Arpad and *Babenberg*, two battleships of 8,340 tons, with engines of 11,000 i. h. p. and a speed of 18 knots, sister ships of the *Habsburg*. The armor belt and the protection of the turrets will be 7.8, 8.2, and 8.6 inches thick, and the protective deck 2.6 inches thick, all of nickel steel. Each ship will carry three 9.4-in. Krupp, twelve 5.9-in. R. F. Skoda guns, twenty-four smaller guns, including machine guns, and two torpedo tubes.

"A," a battleship of 10,000 tons, to take the place of the *Laudon*, which has been struck from the list but will be used as a training ship. It is also reported that this vessel will be of the same size and type as the *Habsburg* and may take the place of one of the two previously mentioned.

DENMARK.

One new battleship of the *Herlof Trolle* type is proposed.

ENGLAND.

In addition to the vessels already laid down, the following vessels have been authorized and ordered:

Name.	Class.	Tons.	To be built at—
10 vessels	Torpedo-boat destroyers	350	Various.
No. 108	Torpedo boat, first class	150	Chiswick.
5 vessels	Submarine boats	120	Barrow.
Assistance	Repair ship	9,600	Glasgow.

The following is a list of the new vessels to be laid down 1901–1902:

Battleship, first class	Portsmouth.
Do	Devonport.
Do	Contract.
Armored cruiser	Chatham.
Five armored cruisers	Contract.
Two protected cruisers, third class	Do.
Two sloops	Sheerness.
Ten torpedo-boat destroyers	Contract.
Five torpedo boats	Do.
One distilling ship	Do.

The details of these vessels are not yet settled. It was first reported that the battleships were to be of 18,000 tons and to be 440 feet long, practically copies of the latest American vessels. They were to carry, according to this report, four 12-in., eight 7.5-in. in four turrets, and ten 6-in. guns on the main deck.

The latest report announces that the three battleships will be named *King Edward*, *Commonwealth*, and *Dominion*, that they will be 450 feet long over all and have a displacement of 16,500 tons. The main armor belt is to be 9 inches thick and extend from the stem to abaft the after barbette. Above it there is to be a shorter belt of 8 inch armor covering the space between the barbettes and above this a belt of 7 inch armor protecting the 6-in. battery. The principal armament is to consist of four 12-in. guns, four 9.2-in. and ten 6-in. R. F. guns. The engines are to develop 18,000 i. h. p. and give a speed of 18.5 knots.

The six armored cruisers are to be of the type of the *County* class, but instead of carrying two 6-in. guns in the turrets forward and aft they will carry one 7.5-in. gun in each turret.

The order for the five submarine boats to be built for the English Admiralty has been placed with Messrs. Vickers, Sons & Maxim, at Barrow. Some progress has already been made with the work. They are of an improved Holland type, and do not resemble any of the French boats. The dimensions of the boats will be: length over all, 63 feet 4 inches; diameter, 11 feet 9 inches; displacement, 120 tons when submerged. There will be one tube for firing torpedoes. The maximum speed on the surface will be from 9 to 10 knots, and when submerged from 6 to 7 knots.

FRANCE.

The following vessels have been authorized, and those having names have been ordered, but no information has yet reached the Office as to their having been laid down. Those marked * are the new vessels authorized by the law passed in February, 1901.

Name.	Class.	Tonnage.	Built at—
Patrie*	Battleship, first class	14,865	Contract.
République *	do	14,865	Brest.
Victor Hugo*	Armored cruiser	12,550	Toulon.
Arc*	Torpedo-boat destroyer	303	Contract.
Baliste *	do	303	Do.
Bélier *	do	303	Do.
Bombarde *	do	303	Do.
Catapulte *	do	303	Do.
Dard *	do	303	Do.
Epieu	do	303	Havre.
Francesque *	do	303	Rochefort.
Fronde	do	303	Bordeaux,
Harpon	do	303	Do.
Javeline	do	303	Havre.
Mousquet	do	303	Do.
Mousqueton *	do	303	Contract.
Pistolet *	do	303	Do.
Sabre *	do	303	Rochefort.
Sagaie	do	303	Havre.
277 *	Torpedo boat, first class	86	Saigon.
246 to 251	do	90	Contract.
253 to 265	do	90	Do.
266 * to 276 *	do	87	Do.
Two vessels *	Submarines	106	Cherbourg.
Six vessels *	do	106	Toulon.

In April, 1901, it was reported that the Minister of Marine had given orders for the construction of twenty submarines—ten at Toulon, six at Rochefort, and four at Cherbourg—to be of the submarine type, as opposed to submersible boats, and to have a displacement intermediate between that of the *Gymnote*, 30 tons, and the *Morse*, 146 tons, said to be about 70 tons.

GERMANY.

The German program was fully discussed in the last volume of this series, No. XIX. Since that volume was issued the question has arisen as to whether the proposed program would be completed by 1906 instead of 1916. An examination of Table IV, page 19 of that volume, will show that the last of the *new* vessels of all classes proposed for the active battle fleet will be laid down in 1905; that after that year but one *new* battleship is to be laid down, and that for the non-active fleet. *All* the *new* cruisers, both large and small, will have been laid down by 1909, and after that time the construction will be merely to replace older vessels. So it will be seen that the proposed German battle fleet will be practically complete when the vessels laid down in 1905 shall be finished, the new cruisers laid down after 1905 being either for foreign service or the nonactive fleet.

In 1901 there are to be laid down two battleships, H and J, of 13,000 tons; one armored cruiser, C, of 8,870 tons, to replace the *König Wilhelm;* three small cruisers, G, H, and J, of 2,800 tons; and two divisions of torpedo-boat destroyers, of 350 tons, S–102 to S–107, at Elbing, and G–108 to G–113 at the Germania Works, Kiel.

The new battleships will differ considerably from the older ones. The armor plates will be much stronger and form a complete belt, while the speed will be greater. The ships will be longer by 39 feet and broader by 2.5 feet, so that their displacement will be 13,000 tons instead of 11,000. The main armament will consist of 11-in. R. F. guns, the effect of which exceeds that of the 9.4-in. guns by one-half. The increase in displacement will render possible the use of engines of 15,000 i. h. p., with a speed of about 19.5 knots.

GREECE.

There have been ordered built for the Government of Greece two cruisers, four torpedo-boat destroyers, and six torpedo boats. In the discussion which took place in the Chamber on the subject of the increase of the navy, the First Minister declared that there should be constructed four armored cruisers and that the torpedo-boat flotilla should be reconstructed. This proposition was adopted without debate.

It is reported that the vessels mentioned above as ordered are to be built at Graville and St. Nazaire.

HOLLAND.

Three torpedo boats of the *Ophir* class have been built for Holland at a total cost of $336,000. Their names are *Ophir*, *Pangrango*, and

Rindjani. These have all been launched and the first two have had their trial trips.

ITALY.

For the last two years the building of new battleships has practically been at a standstill, due to grave differences of opinion, which existed at the Ministry of Marine itself, as to the best type of ship to lay down, and also to the difficulties experienced in getting the necessary funds from Parliament. These difficulties are believed now to have been surmounted. In June, 1900, it was practically decided to lay down four ships of a medium type between battleships and armored cruisers. These new vessels were to be 442 feet long, with a beam of 62 feet 8 inches, and a displacement of 8,500 tons, while the engines were to give a speed of 20 knots, protection being afforded by a 6 inch water-line belt and a 2 inch armored deck; the armament consisting of twelve 8-in. and eight 3-in. R. F. guns. They were to have been named *Amalfi*, *Genova*, *Pisa*, and *Venezia.*

The ships just mentioned are, however, not to be built; the Minister of Marine, acting under the advice of the Superior Council of the Navy, has decided that the design of the ships is faulty, as it is impossible on so small a displacement to give a vessel the necessary offensive and defensive powers. It has, therefore, now been decided that two new first-class battleships, to be called *Regina Elena* and *Vittorio Emanuele*, are to be laid down at Spezia and Castellammare, respectively. It was at first proposed to call the second one *Vittorio Emanuele III*, but the King expressed himself as opposed to this name. Their details will appear in Section II.

JAPAN.

At the commencement of the war between China and Japan, the latter power possessed a navy of only 30,000 tons, while that of her opponent was 40,000 tons. For defensive purposes Japan has been forced since then to augment her navy until now she possesses a fleet of an aggregate tonnage of 260,000. This enormous expansion has taken place in less than six years and has received the approval of the Diet and of the nation at large.

The authorities now appear to view with suspicion the action of certain powers in greatly reenforcing their Far Eastern squadrons, and a Japanese native paper learns that it has been proposed in Japanese naval quarters to augment the navy to the extent of either 350,000 or 400,000 tons. The proposal is receiving the support of the leading Japanese naval authorities, and of many influential persons outside of naval circles, and it is generally believed in Japan that the scheme will be realized in the near future.

Instructions were sent in the summer of 1900 to the dock-yards at Kure and Yokosuka to build one second-class cruiser at each yard, to be of about 3,200 tons displacement, and to be called, respectively, *Tsushima* and *Niitaka*. Material for their construction has been ordered from abroad, but has not yet been received. They will probably be laid down about the end of the present year.

In December, 1900, eight torpedo-boat destroyers were ordered as follows: To be built at Yokosuka Dock-Yard, Japan, four, to be called *Asagiri*, *Harusame*, *Hayatori*, and *Murasame*. Their dimensions are to be: length between perpendiculars, 227 feet; beam, 21 feet 6 inches; mean draught, 6 feet; displacement, 375 tons; estimated i. h. p., 6,000; speed, 29 knots; bunker capacity, 100 tons; armament, one 12-pdr. and five 6-pdr. R. F. guns and two torpedo tubes. To be built by Thornycroft, in England, two, to be called *Asashiwo* and *Shirakuma*. Dimensions: length between perpendiculars, 216 feet 8 inches; beam, 20 feet 9 inches; mean draught, 6 feet; displacement, 333 tons; estimated i. h. p., 7,000; speed, 31 knots; bunker capacity, 90 tons; armament, same as the preceding. To be built by Yarrow & Co., England, two, to be called *Akatsuki* and *Kasumi*. Dimensions: length between perpendiculars, 220 feet 3 inches; beam, 20 feet 6 inches; mean draught, 5 feet 4 inches; displacement, 325 tons; estimated i. h. p., 6,000; speed, 31 knots; bunker capacity, 90 tons; armament, same as the preceding.

Five torpedo boats, Nos. 39 to 43, built by Yarrow and put together at Yokosuka, have been completed, also Nos. 44 to 46, of 84 tons, and 47 to 49, of 80 tons, built by Schichau and put together at Kure. In addition to these Nos. 50 to 56, of 53 tons, have been completed and had their steam trials. Nos. 57 to 59 are on the stocks at Kure and are expected to be completed in August, 1901. Two boats of 83 tons, built by Schichau, Nos. 60 and 61, are being put together at Sasebo, as are also Nos. 62 to 66, built by Yarrow. The machinery is already set up in the shops and the hulls are being assembled rapidly.

Five other torpedo boats of 88 tons are to be built, three at Sasebo and two at Yokosuka. The material for them has been ordered and work on them is expected to begin about the end of the present year. Their dimensions are to be as follows: length between perpendiculars, 131 feet 6 inches; beam, 16 feet 3 inches; mean draught, 3 feet 4 inches; displacement, 88 tons; estimated i. h. p., 1,200; speed, 23.5 knots; bunker capacity, 14 tons; armament, two 3-pdr. R. F. guns and three torpedo tubes.

In November, 1900, orders were sent to the Kure dockyard to build six torpedo boats of 150 tons each, to be named *Awataki*, *Hato*, *Hibari*, *Kari*, *Kiji*, and *Tsubame*. A portion of the material for these boats has been received, but none of them has as yet been laid down. The work on the engines and boilers is well advanced and the engines are already set up in the machine shops at the yard. Their dimensions are to be: length between perpendiculars, 147 feet 7 inches; beam, 16 feet; mean draught, 4 feet 9 inches; displacement, 150 tons; estimated i. h. p., 4,200; speed, 29 knots; bunker capacity, 25 tons; armament, three 3-pdr. R. F. guns and three torpedo tubes.

MEXICO.

It is reported that Mexico is to have an addition to her navy which will more than double the fleet. The intention is to build eight gunboats of 1,000 tons, to steam at 16 knots, and two moderate-sized torpedo boats. At present the Mexican navy consists of one 1,200-ton gunboat of 15 knots speed, two 450-ton vessels of 11 knots, and two smaller vessels.

NORWAY.

It is proposed to build for the Norwegian navy a submarine boat of 120 tons displacement, of the Holland type, to steam at 9 knots on the surface and at 7 knots when submerged. The coasts of Norway with their numerous fiords are very well suited for the use of these vessels and offer unusual facilities for their operations.

RUSSIA.

The Russian budget for 1901 authorizes the construction of one cruiser of 3,285 tons at the Baltic Works, to be called the *Almas*, two cruisers of 6,300 tons at Nicolaief and Sevastopol, to be called, respectively, the *Kagul* and *Otchakoff*, and six torpedo-boat destroyers of 350 tons.

The characteristics of the 6,300-ton cruisers are as follows: length between perpendiculars, 412 feet; beam, 53 feet 6 inches; draught, 20 feet 8 inches; displacement, 6,300 tons. The speed is to be 23 knots and they will resemble the *Varyak*. The two engines are to develop 20,000 i. h. p.; boilers to be of the Normand type.

There are also building, at the Baltic Works, a battleship of the *Borodino* type, of 13,500 tons, to be called the *Slava*, and at Galernia Island, St. Petersburg, a cruiser of 6,300 tons to be called the *Vityas*. A fire at the last-named yard on June 13, 1901, destroyed the building slips, many buildings, and the cruiser *Vityas*, into which about 700 tons of metal had been built, the loss being about $5,000,000.

Two cruisers of 3,200 tons, similar to the *Novik*, are building at St. Petersburg, also a collier of 7,200 tons to be called the *Kamçhatka*. On the Volga there is building a transport of 754 tons for service on the Caspian Sea. She is to be called the *Araks*.

There has been ordered and laid town at Kiel a transport, to be named the *Okean*, of 12,000 tons displacement, with a maximum speed of 18 knots, capable of steaming at reduced speed and with her own coal supply (800 tons) a distance of 10,000 miles and at the same time transporting a cargo of 4,000 tons of coal.

Besides service as a transport she is to be a school of instruction for machinists and firemen, for which purpose she will be fitted with Schultz, Belleville, Niclausse, and Yarrow boilers, and besides her main engines will be supplied with all auxiliary engines in use in men-of-war.

There are now eight torpedo-boat destroyers of 350 tons displacement and 26 knots speed building at the Neva Works. There have been ordered five torpedo boats of 150 tons from the Newsky Engineering Works at St. Petersburg, to be of the *Cyclone* (French) type, which is 144.2 feet long, 15.2 feet beam, 10 feet draught, and a speed of 30 knots with 4,200 i. h. p.

An electrically propelled submarine boat, designed by a lieutenant of the Russian navy, is being built at Kronstadt by order of the Government. It is due to be delivered by the end of June.

SWEDEN.

It has been decided to build a vessel for coast-guard service, to be equipped for ice-breaking, towing, and wrecking purposes. Her dimensions are: length, 131 feet; beam, 25 feet; draught forward, 8 feet; aft, 10 feet; displacement, 300 tons. With 500 i. h. p. the speed is to be 12.5 knots. The armament is to consist of two 6-pdrs. forward and one of the same caliber aft.

The latest budget calls for the construction of a new battleship in 1901, of which the details have not as yet been settled.

One torpedo-boat destroyer of 30 knots speed has been ordered.

Two first-class torpedo boats have been ordered built at the navy-yard at Carlskrona. They differ from the *Blixt* class in having a finer run and in the suppression of the overhang; also having balanced rudders.

Having got together their battleships, the Swedes have begun to feel the need of cruisers, without which any fleet is blind. The torpedo gunboats do not carry enough coal, nor are they sufficiently seaworthy to scout in all weathers and circumstances; hence the demand for large cruisers. It is still necessary, however, that these conform to the requirements for Swedish battleships, namely, great handiness and light draught, without which they would be aground in no time. The maximum possible armament is also demanded. All told, this, it will be readily seen, is a problem calling for very careful handling, several of the desired qualities being antagonistic to each other.

The desired qualities were set before the designers in the following order: (1) light draught; (2) great handiness; (3) the highest possible speed; (4) coal enough to keep at sea at full speed for a week or more; (5) as large an armament as possible, with the maximum arc of fire to all guns; (6) protection to guns and water-line.

In order to satisfy the first two requirements, the limit of displacement was fixed at 4,000 tons. The vessel, of which an illustration is given, is the result, and an inspection of this illustration will show that she embodies a novel feature in gun placing.

The following details regarding the ship have been given out: length, 328 feet; beam, about 50 feet; draught, about 17 feet; displacement, 4,000 tons.

Protection: double turtle-back deck; eight turrets, 4 or 5 inch armored hoists to each; two armored hoists for 6-pdrs.; armored conning tower and communicating tube; complete cellulose belt rising 3 feet above the water line. All the armor to be of Krupp steel.

Armament: eight 6-in. 45-cal. R. F. Bofors guns; twelve 6-pdr. R. F. Bofors guns; two submerged torpedo tubes of the Elswick pattern.

The boilers will be of the Yarrow type and the estimated speed is 22 knots.

It will be noted that the ship can fire six of her eight 6-in. guns on the broadside, and these pieces are protected very thoroughly. Each gun is in a closed turret and each turret is balanced and revolves on its armored hoist. Nothing carried by any cruiser afloat could hurt these turrets. Even if only 4 inches thick this amount of Krupp armor, inclined as it is on these turrets, is equal, it is said, to 20 inches of vertical wrought iron.

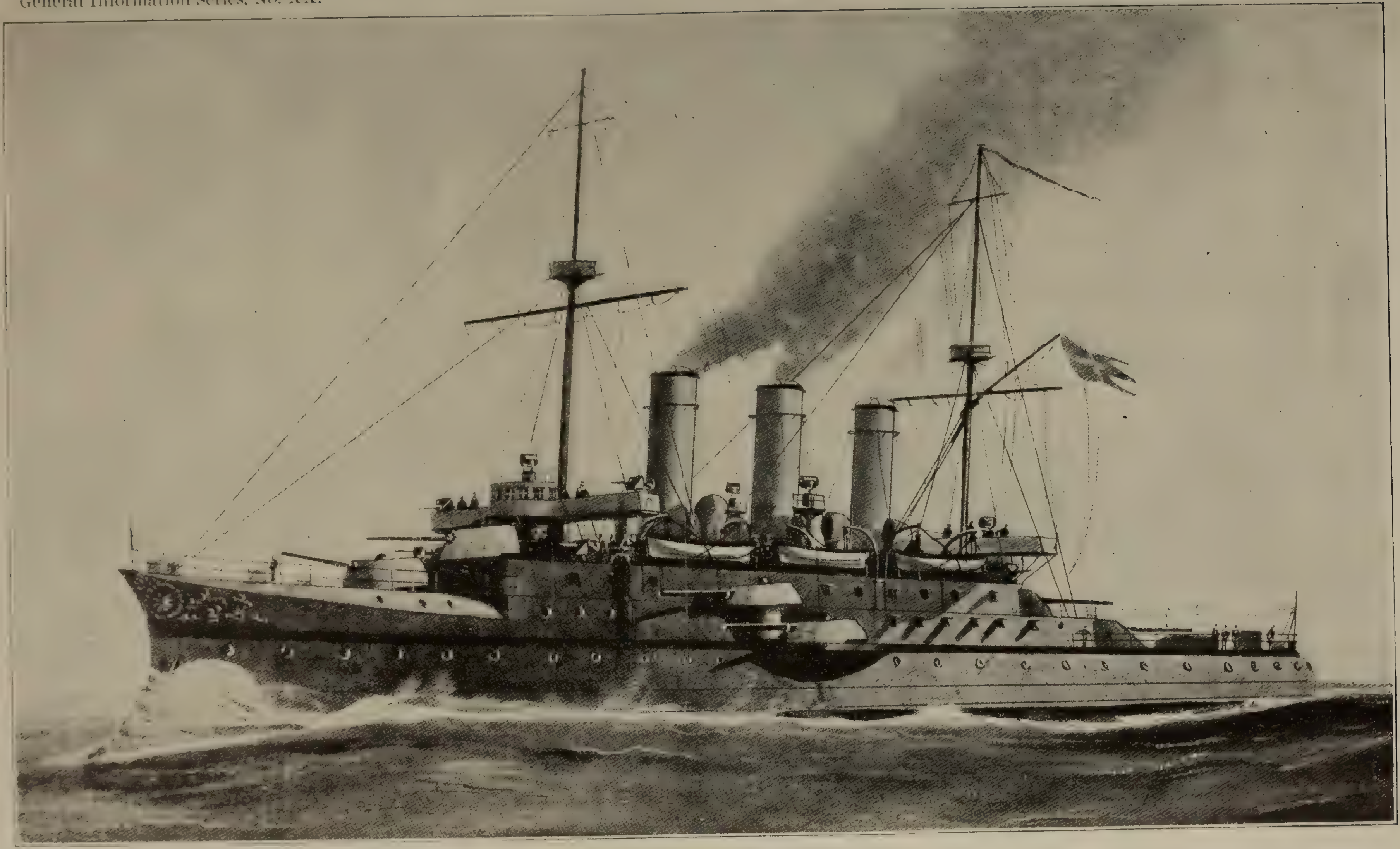
A writer in the *Engineer*, commenting on this vessel, says:

> The problem is, How will the superposed turrets stand the test of battle? They fire, it will be noted, over each other in the end-on position. Swedes say that experiments have been carried out very fully, and that no harm results to the people underneath. This is a hard statement to swallow; but it is worthy of note that the firing over would only very rarely be required. In all normal positions there is no interference. Swedish officers have no faith in a pair of guns in a turret for small ships; they consider the shock of the recoil to be too great, and here they are probably reasonable. Certainly to have had four turrets with the guns in pairs would have been a bold experiment, nor is it one that looks promising. If this Swedish idea has anything whatever in it something like a revolution will be effected in cruiser design. The off-side battery in a cruiser is useless. The cruiser that gets most guns and presumably most hits in will win and send her adversary below.

Plans for a new submarine boat have been recently submitted to his Government by a Swedish engineer, Euroth, which differ in many respects from those adopted in America and in France.

They provide for a boat whose dimensions are to be: length, 83 feet; breadth, 13 feet 2 inches; depth, 11 feet 6 inches, with a displacement of 146 tons when submerged and 142 tons on the surface.

The boat is to be fitted with two triple-expansion engines with a total of 100 i. h. p., and its estimated speed is 12 knots on the surface and 6 knots under water. Steam power will be used only on the surface. Under water the boat will be propelled by means of com-



PROPOSED CRUISER FOR SWEDEN.

pressed air, which will be stored in cisterns forward and aft. The boilers, as well as the air chambers, will be constructed to resist a pressure of 285 pounds per square inch.

The boat will be steered by a complicated system of rudders, consisting of two horizontal and two vertical rudders. The horizontal rudders will be worked separately by hydrostatic pressure, and will maintain the vessel at a uniform depth. The descent of the vessel under water will be effected by the admission of water into cylindrical tanks, which can be filled and emptied without in any way disturbing the balance of the boat. The steam, after condensation, will be conducted into a tank amidships. The condensed air used in propelling the machinery will also be conducted through the condenser, and, when cooled, into the body of the ship, where it will serve to regenerate the air used in breathing. The used-up air will be blown outward into the water by a clever contrivance.

As fuel the best oil will be employed; it will be stored in tanks, which may be emptied without effecting the balance of the boat. The vessel itself will be constructed to withstand the water pressure at a depth of over 200 feet. In the event of this depth being exceeded an apparatus acting automatically will expel the water from the tanks by means of compressed air. The boat then will mount rapidly to the surface.

The vessel, according to the designs, is to be armed with four 18-in. Whitehead torpedoes, which will be ejected from tubes placed forward and aft. The cost of the vessel is estimated at $85,165.

TURKEY.

A contract has been signed with the Cramp Ship and Engine Building Company, of Philadelphia, to construct a protected cruiser of about 3,000 tons displacement, to be of the *Denver* type but of greater speed.

Her dimensions are to be as follows: length on water line, 240 feet; beam, 42 feet; draught, 16 feet; displacement, 3,250 tons.

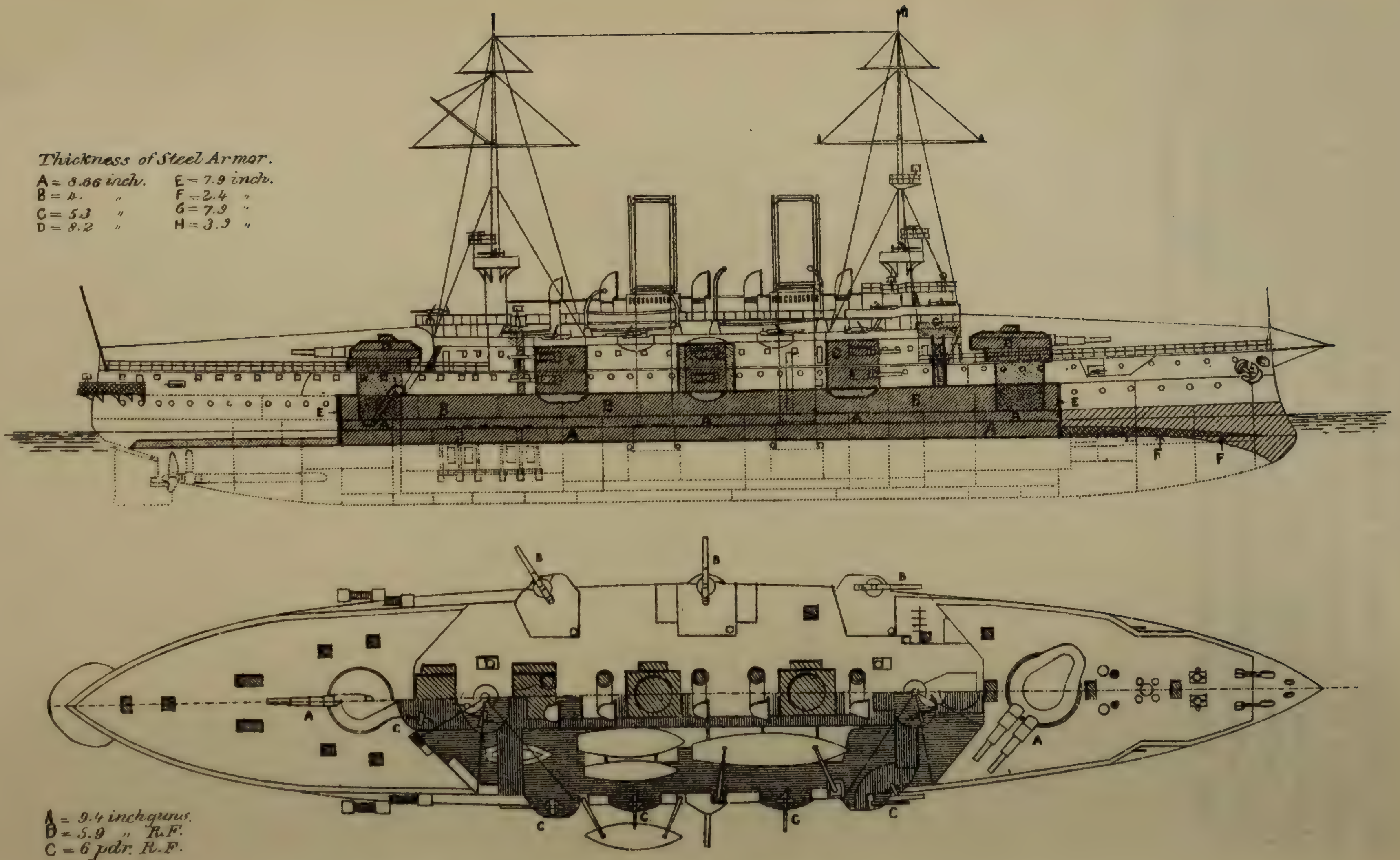
She will have two masts, fitted with military tops and signal yards, four search-lights, and the usual protective deck.

The armament will consist of two 6-in. R. F. guns, one forward and one aft on the upper deck in the middle line of the ship, protected by armored shields; eight 4.7-in. R. F. guns, four on each broadside, with armored shields; six 3-pdr. R. F. guns, and six 1-pdr. machine guns all fitted with shields.

She will be equipped with two triple-expansion engines and with Niclausse water-tube boilers, and is expected to develop 12,000 i. h. p. and to make a speed of 22 knots.

There has been much discussion of a plan to reconstruct and modernize eight old ironclads belonging to the Turkish navy, but up to the present time the project has not materialized.

For some time the Turkish Government has been negotiating with Armstrong & Co., of England, for the construction of a cruiser. Early in June, 1901, it was reported from Constantinople that the business connected with the order had been definitely settled. The new vessel is to be of the same dimensions and armament as the cruiser building at Philadelphia. Work on it is to be commenced as soon as the initial payment has been made.



HABSBURG, AUSTRIAN BATTLESHIP, 8,340 TONS.

SECTION II.

NEW SHIPS AND TORPEDO BOATS.

AUSTRIA.

HABSBURG.

This battleship is the type ship, and the *Arpad* and *Babenberg* are to be similar.

The first keel plates of the *Habsburg* were laid in March, 1899, at the yards of the "Stabilimento Tecnico Triestino," at Trieste, and she was launched September 9, 1900.

The principal dimensions of this class of ships are:

Length between perpendiculars	feet	353.00
Extreme breadth at midship frame	do	64.96
Mean draft	do	23.29
Height from lower edge of keel to sheer line of upper deck	do	41.00
Displacement	tons	8,340

The buoyancy of the ship is insured by a double bottom extending over 63 per cent of the total length and subdivided into numerous compartments. In addition thereto a system of water-tight bulkheads extends up to the gun deck, that is to say, 10.49 feet above the water-line, there being in all 174 separate water-tight spaces.

The system for pumping out water comprises two main drainage pipes built into the bilge above the inner bottom, the larger one of which is connected with the centrifugal pumps, the smaller one with six steam pumps and two hand pumps. Not all of the compartments are directly connected with these two main drainage pipes; from the more remote compartments the water is conducted through cocks and valves in the bulkheads to the pump strainers.

The framework of the ship consists of the vertical keel and five longitudinal frames on each side, the first, third, and fifth of which are water-tight. The transverse frames are intercostal; between each two water-tight frames are two or three ordinary ones. The fifth longitudinal indicates the height of the orlop deck and of the lower edge of the armor belt. Up to this height the ship has no continuous deck; only a platform deck forward and aft and an armored orlop deck, which also consists of two separate parts forward and aft. The middle deck above the armor belt extends from bow to stern; the gun deck and upper deck are likewise continuous. Above the latter is a hurricane deck comprising a forecastle and a poop, together with two wide deck parts running along the ship's sides, leaving the central part of the upper deck open. The living spaces are on the gun deck, the extremities of the middle deck, and the covered parts of the upper deck.

The high freeboard (17.88 feet) insures to the ship a sufficient degree of stability, which is further guaranteed by the initial stability represented by a metacentric height of from 2.70 to 3.35 feet and by a good distribution of weights.

The rolling movements are moderated by bilge keels on each side which are 2.13 feet wide and extend over 47 per cent of the ship's length.

The stem, which represents a weight of 23 tons, terminates in a ram and is cast in one piece of soft steel. The sternpost is likewise cast in one piece and weighs 13.6 tons.

The hull is built of soft ingot steel treated according to the Siemens-Martin process. The total weight of the steel used in the construction of the ship is a little over 2,400 tons. The use of wood has been almost entirely avoided. It has been employed only in some places to improve the appearance or the habitability of the ship, or where it is not exposed to any danger from fire under the armor, namely as planking for the upper decks and as backing for the side armor and under the plates of the transverse armored bulkheads. All the decks are entirely covered with steel plates; the upper and hurricane decks have wood planking over these, the lower decks are covered with linoleum, and the upper decks with some other special floor-covering material, such as xylolith, papirolith, or lapidith.

All of the steel material used in the construction of the *Habsburg* has been furnished by Austro-Hungarian works and is of the highest quality.

The armor belt extends over 63 per cent of the ship's length and reaches from 4.42 feet below the water line to 3.6 feet above. It is 8.66 inches thick and connected at both ends by 7.9 inch transverse bulkheads. The plates rest on a 7.1 inch backing of teak wood with a 1 inch sheet-metal backing supported by angles and strong vertical frames. The lower edge of the armor belt coincides with the line of the fifth longitudinal frame and continues forward and aft as the lateral limiting line of the two armored decks.

From the lower edge of the two transverse bulkheads the two underwater armored decks extend towards the extremities of the ship, the forward one terminating at the ram stem, the after one at the sternpost. The thickness of the plates of the forward armored deck is 2.4 inches, of the after deck 2.6 inches.

From the forward end of the armor belt to the stem the ship's sides are built of two layers of sheet metal of 0.48 inch each, over which are riveted armor plates 1.6 inches thick. This side armor of the bow, together with the forward protective deck, forms a strong reenforcement for the ram bow. There is a third protective deck of 1.6 inches thickness at the upper edge of the armor belt, that part of the middle deck formed by the belt and its transverse bulkheads being covered with two layers of 0.8 inch plates. The large hatches in this part of the deck for smoke-pipes and engine skylights, as also the smaller hatchways, are protected by armored coamings.

Above the middle deck, and forming an exact continuation of the lateral and transverse bulkheads of the belt, is the 4 inch armored citadel, the sides of which rest on a double layer of sheet metal 0.5 inch thick. This protection extends to the gun deck.

The 5.9-in. guns on the upper and gun decks are protected by twelve redoubts, in two tiers one above the other, each designed to receive one gun. The outer sides of these redoubts or casemates are 5.3 inches thick, those in the interior of the ship from 2.4 to 3.2 inches.

The 9.4-in. guns, installed on the open parts of the upper deck, are in barbette turrets 8.2 inches thick. The ammunition hoist and mechanism of the mount are protected by an armored shaft 5.3 to 7.1 inches thick and extending to the middle deck. The small-caliber guns have no fixed armor protection, being equipped only with protective shields secured to the mounts.

The conning tower on the forecastle is built of 7.9 inch armor plate; from the floor of the tower to the gun deck extends a 5.9 inch armored tube. Under the after bridge is the deckhouse containing the engine telegraph, steering indicator, etc., built of 3.9 inch armor plates, with a tube of 2 inch armor.

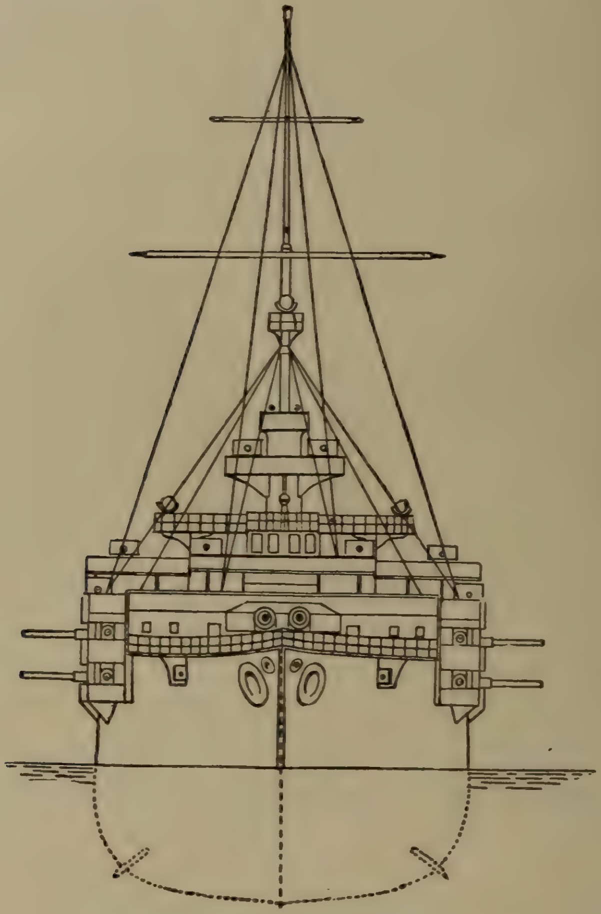
The total armor-plate material of the ship represents a weight of 2,250 tons.

The armament consists of three 9.4-in. guns, twelve 5.9-in. and ten 12-pdr. R. F. guns, twelve 37-millimeter machine guns, and four 8-millimeter automatic guns. Two of the 9.4-in. guns are installed in the forward barbette turrets, the third one in the after barbette turret. The training and elevating gear, as well as the ammunition-conveying devices for these guns are operated electrically, but may also be operated by hand. The twelve 5.9-in. Skoda guns, installed in redoubts on the gun and upper decks, are fired through embrasures. Four of these guns can be trained right ahead and four right astern. They are really coupled in turrets, one being above the other, thus forming a kind of double turret. The ammunition hoists leading directly from the redoubts to the ammunition rooms are operated electrically and adapted to supply 8 rounds a minute, which is the rapidity of fire of these guns.

The small-caliber guns are installed without armor protection on the decks and bridges. The 8-millimeter automatic guns are mounted in the tops of the military masts, two in each.

Besides two of the 9.4-in. and four of the 5.9-in. guns, two 12-pdr., eight 37-millimeter, and two 8-millimeter automatic guns can fire right ahead, while the stern fire is represented by one 9.4-in. gun, four 5.9-in., four 12-pdr., four 37-millimeter, and two 8-millimeter automatic guns. The broadside fire is still more powerful.

The torpedo armament consists of two submerged launching tubes for Whitehead torpedoes.



BOW VIEW OF HABSBURG.

There are two main engines of the four-cylinder triple-expansion type. The cylinders are of the following dimensions: One high-pressure, 30 inches diameter; one mean-pressure, 48.8 inches diameter, and two low-pressure, 56.3 inches diameter. The connecting rods are 6.25 feet long.

The three-bladed twin screws have a diameter and pitch of 16 feet. The developed surface of the six blades is 59 square feet and is calculated for an efficiency of 11,900 i. h. p., with about 136 revolutions per minute.

The steam of the low-pressure cylinders enters two surface condensers of 7,535 square feet cooling surface each. The sea water required for cooling is furnished by two centrifugal pumps, operated by steam pumps of their own.

Steam is supplied by sixteen Belleville boilers, installed in two boiler rooms, with a total grate surface of 856 square feet and a heating surface of 30,360 square feet, capable of furnishing sufficient steam at 300 pounds pressure per square inch for the main and auxiliary engines. The pressure will be usually reduced, however, to 250 pounds per square inch for the main engines and to 156 pounds per square inch for the auxiliary machinery.

Each group of boilers has a smoke pipe of 9.5 feet diameter and 80 feet high above the grates.

In each of the four fire-rooms are two ventilators. For conveying the ashes overboard four hydraulic ash-ejectors are provided, served by two steam pumps, which latter at the same time form part of the general fire-extinguishing and drainage system.

The coal, in all 840 tons, is stored partly below and partly above the middle deck. It can be shipped through openings in the ship's sides or through hatches with tube connections from the decks to the bunkers.

The steam steering apparatus comprises a partly balanced rudder of 235 square feet surface, equal to one thirty-third of the longitudinal section. By means of a Harfield tiller apparatus the helm can be put from hard a-port to hard a-starboard in thirty seconds, with the ship under full steam. The two steam steering engines are installed in the main engine room. A 3.7 inch transmission shaft leads on either side to the steering room, where auxilliary hand-steering wheels are installed. By proper couplings either of the two engines or the hand-steering apparatus can be connected with the tiller mechanism.

Besides the main steering stations at the steam-steering apparatus in the engine room the ship can be steered from six other points. The transmission network extends over the whole ship, so that, in case of injury to any part, other intact connections can be made.

The whole steering mechanism, comprising tillers, engines, and transmission system, is protected by armor.

The ship has two main stockless anchors of the Tyzak type, weighing 11,000 pounds each. The anchor cables, of 2.25 inches diameter, are stowed in the space below the protective deck. The anchor-weighing apparatus consists of a two-cylinder horizontal steam engine actuating two small chain windlasses and a large capstan; the latter can also be operated by hand.

Of the 14 boats, one is a vedette boat 45 feet long, and one a steam launch. The boats are installed on the hurricane deck and adapted to be lowered by means of revolving cranes.

Speaking tubes and an extensive telephone system provide for the transmission of commands.

Electricity is employed on board the *Habsburg* for lighting, operating the ventilators, training and elevating the 9.4 in. guns, and running the ammunition hoists of these and the 5.9 in. guns. The necessary current is supplied by the central installation, consisting of six dynamos, which furnish direct and alternating current and are protected by armor. The ship carries six search-lights on the bridges, galleries, and platforms.

The living rooms for the commander and superior officers are located on the gun deck, as are also extensive quarters for the men. The staff is to occupy the after portion of the middle deck, while the forward part will contain quarters for men. The messes, galleys, etc., are located on the gun deck. The laundry and a number of bathrooms are on the middle deck.

The rooms are to be heated by steam. Refrigerators and a cold-air engine are also provided.

The necessary drinking water will be furnished by a distilling installation of a capacity of 7,000 liters in twenty-four hours. A system of piping having its own pumps extends all through the ship, connecting the fresh-water tanks with the galley, bathrooms, etc. Another system of larger piping, fed by six powerful steam pumps, distributes sea water to every part of the ship, to be used in case of fire, for washing decks, etc.

The lower spaces of the ship are ventilated by electric ventilators, the upper ones by the natural supply of air. Engine and boiler rooms will be equipped with steam-operated ventilators.

The *Habsburg* is to be completed within eighteen months from the date of launching. The speed to be developed at the trials is 18.5 knots, with 11,900 i. h. p.

KAISER KARL VI.

This armored cruiser was built at the Stabilimento Tecnico, at Trieste. Keel laid June 20, 1896; launched October 4, 1898, and placed in commission May 28, 1899.

She is of the following dimensions: length, 367 feet 5 inches; beam, 56 feet 4 inches; draught, 20 feet 4 inches; displacement, 6,250 tons. Hull is of Siemens-Martin steel; stern post, rudder, and shaft brackets of cast steel. She has a ram bow, one military and one signal mast, and three smoke-pipes. Steaming radius at 12 knots, 3,500 knots, and at 9 knots, 5,000 knots. Double bottom extends over 70 per cent of the ship's length, under engine, boiler, and ammunition rooms, divided into many water-tight compartments. Two bilge keels, 35.5 inches deep, extend over half of her length. Rudder surface, 200 square feet, and two steam steering-engines.

The main protection consists of a nickel-steel belt, 8.66 inches maximum thickness, over 70 per cent of the ship's length, 6.5 feet wide, extending 3.75 feet below the water-line. This belt is limited forward [illegible] transverse bulkheads 7.9 inches and 6.9 inches thick, respec- [illegible] pon it rests a 1.25 inch protective deck, which is extended forward and aft from the lower edges of the transverse bulkheads, with a thickness of 2.4 inches.

Above the protective deck is a citadel 2.4 inches thick athwartship, and 3.2 inches thick fore-and-aft. At its forward and after ends and on either side amidships are casemates or redoubts 3.2 inches thick for the 5.9-in. R. F. guns, which are separated by splinter screens 0.8 inch thick.

The eight 5.9-in. rapid-fire guns are completely inclosed in armored casemates. The cylindrical gun shields completely cover the ports, and there is a rectangular opening in the side armor, 12 inches long, for a sighting port in addition to the sights on the gun itself. This port is about 5 feet above the deck, and affords a large field of view, necessitated by the fact that the gun is completely enclosed. The barbettes forward and aft are protected by 8 inch armor. Ammunition hoists of 5.9-in. guns protected above protective deck with 1.2 inch armor, hatch coverings of engine and boiler-rooms by 3.94 inch armor. Total weight of armor, 23 per cent of displacement.

Electric installation for lighting and operating ventilators, ammunition hoists, and training and elevating gear of 9.4-in. guns. Four search-lights, and one night signaling apparatus. (Sellner system.)

The armament consists of two 9.4-in. R. F. Krupp guns, 40 calibers long, in fixed barbettes; angle of train of guns, 260 degrees. Initial velocity of shot, 2,300 foot-seconds; weight, 475 pounds; energy, 17,650 foot-tons, and power of penetration, 32 inches of wrought iron. Electric firing.

Eight 5.9-in. R. F. Skoda guns, 40 calibers long. In bow, stern, and either broadside, two each. Rapidity of fire, 10 shots per minute.

Two 12-pdr. boat guns, eighteen 3-pdr. R. F. guns, two machine guns, and two broadside torpedo-launching tubes.

Engines: Two four-cylinder triple-expansion engines, driving twin screws. Diameters of cylinders, 36, 55.5, 60.5, and 60.5 inches. Stroke, 3.1 feet.

Boilers: Eighteen Belleville boilers, with feed-water heaters. Heating surface, 13,980 square feet; grate surface, 2,798 square feet; 54 furnaces; steam pressure, 260 pounds in the boilers and 180 pounds at the engines; diameter of screws, 16 feet; pitch from 15.5 to 19.1 feet; 70 auxiliary engines.

	Tons.
Weight of armor	1,400
Weight of engines and accessories	1,100
Weight of coal	820

The displacement during trial trips was 6,325 tons with a draught forward of 19 feet and aft 22.2 feet.

Progressive trial trips of 3 miles.

Number.	Revolutions.	I. H. P.	Speed.
			Knots.
1	60	1,240	10.16
2	81	2,800	13.52
3	101	5,800	16.66
4	110	7,550	18.17
5	121	10,200	19.71
6	127	11,500	20.56
7	129	12,900	[1] 20.83

[1] No. 7 was a four-hour trial trip.

SZIGETVAR.

This torpedo cruiser, the third representative of the *Zenta* class, was laid down in May, 1899, and launched October 29, 1900, at the yard of the construction arsenal at Pola. This new ship, with her two sister ships, the *Aspern* and *Zenta*, recently stationed in Chinese waters, will compose a uniform division of modern torpedo cruisers.

Like her sister ships, the *Szigetvar* is built entirely with home workmanship and machinery, and, like them, will unite great defensive power in gun and torpedo armament with high speed and great radius of action.

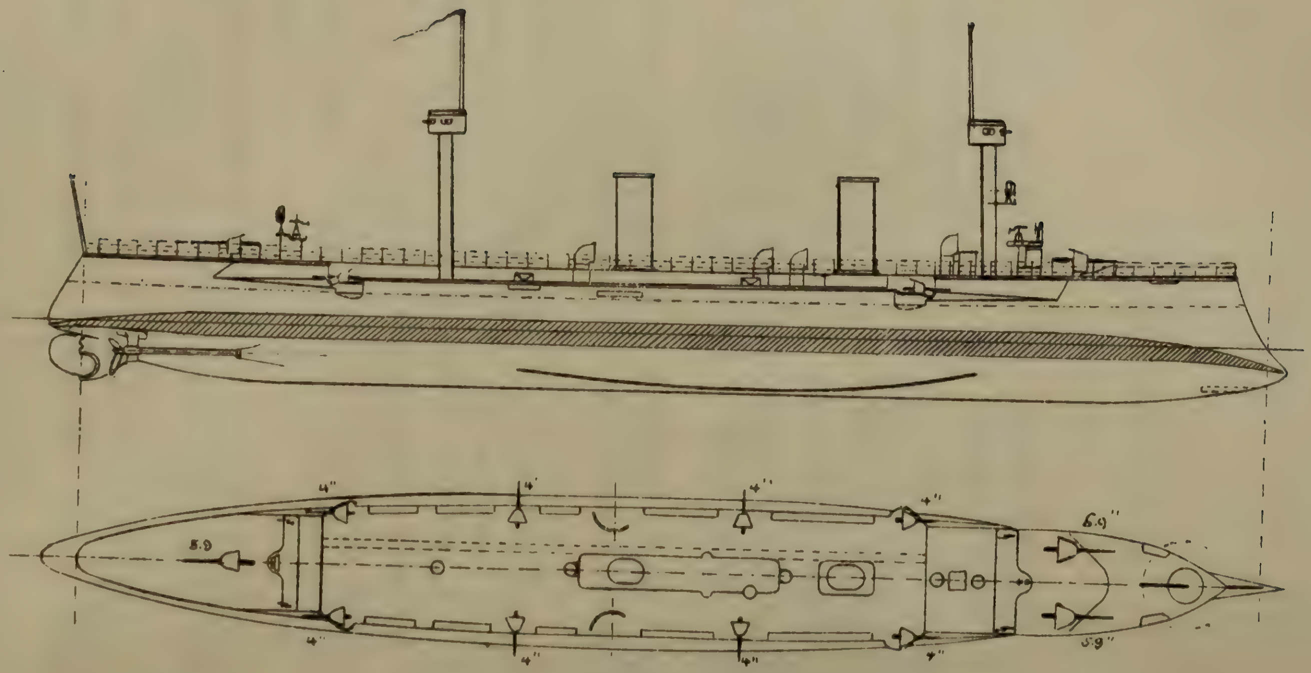
Her dimensions are: length over all, 316 feet; length between perpendiculars, 302 feet; beam, 38 feet 6 inches; mean draught, 14 feet; displacement, 2,400 tons.

The engine and boiler installation, as well as other vital parts located below the water-line, are protected by an armored deck of turtle-back shape, extending from bow to stern, descending forward and aft 3.2 feet below the water-line and rising 4 feet above it in the region of the engine-rooms. The sponsons of the 4.7-in. guns are protected by 1.4 inch steel plates. The conning tower is built of two thicknesses of 1 inch plates.

The armament consists of eight 4.7-in. 40-cal. R. F. guns on central-pivot cradle mounts, one on the forecastle, one on the poop, and the others in broadside, the forward and after guns on each side being arranged so as to fire in a fore-and-aft line; ten 3-pdr. R. F. guns, and two automatic machine-guns. There are two training torpedo tubes for 18-in. torpedoes.

By this installation of guns three of the 4.7-in. guns can be brought into action in the direction of the bow or stern and five on each broadside. These five guns can fire 30 rounds per minute.

There are two four-cylinder triple-expansion engines installed in comparatively small spaces. Their total efficiency with forced draft is 8,000 i. h. p., and the speed should be 20.5 knots per hour. Each engine has its own condenser, with a cooling surface of 10,100 square feet.



HAI-YUNG, CHINESE PROTECTED CRUISER, 2,900 TONS.

Steam is supplied by eight water-tube boilers of the Yarrow type, which are installed in groups of four in two water-tight compartments. The boilers are able to get up steam, even with cold water, in one hour from the time of lighting the fires. The total weight of the machinery, including the boilers filled with water, condensers, and piping, is 500 tons.

The drainage system of the vessel is capable of pumping out 1,000 tons of water per hour. In order to further guarantee the buoyancy of the ship, the interior is divided into numerous water-tight compartments. The steering apparatus is of the Harfield type. The rudder, having a surface of 118 square feet, can be operated from four steering stations by steam or hand power. The diameter and mean pitch of each of the three-bladed bronze propellers are 12 feet.

There are two smoke-pipes and two masts, the latter adapted for carrying sail of a total area of 4,250 square feet, when desired to relieve the engines.

The coal-bunker capacity is 500 tons, which will give a radius of action of 4,000 miles at the economic speed of 12 knots.

The inside of the ship is lighted with 200 incandescent lights, the outside by two 24 inch search-lights of 24,000 candlepower each.

CHINA.

HAI YUNG.

Protected cruiser, built at the Vulcan Works, Stettin, Germany. Length, 328 feet; beam, 41 feet; draught, 17 feet; displacement, 2,900 tons; i. h. p., 8,000; speed, 19.5 knots. Triple-expansion engines; four double-ended fire-tubular boilers; coal capacity, 583 tons. Forecastle and poop decks; two funnels; two masts, with a military top on each mast. She has a 2 inch conning tower under the forward bridge, and a 3 inch protective deck the whole length of the ship. Ammunition hoisted by hand, and guns fitted for firing by percussion.

The armament consists of three 5.9-in. 40-cal. R. F. Krupp guns, manufactured in 1897, two on the forecastle, one on the poop; eight 4-in. 40-cal. R. F. Krupp guns in broadside, the two forward and the two aft being mounted in sponsons. All the R. F. guns are protected by 1 inch gun shields. Six 1-pdr. R. F. Hotchkiss guns, one at each end of forward and after bridges, and two on the forecastle, all protected by light gun shields. Six Maxim guns, three in each top.

There are two search-lights, one on a platform on the foremast above the forward bridge and one on the after bridge.

She has three torpedo tubes, one on each beam with above-water discharge, and one in bow with under-water discharge and carries nine Schwartzkopf torpedoes.

It is reported that the two above-water torpedo tubes are to be removed and replaced by two 4-in. R. F. Krupp guns.

DENMARK.

BESKYTTEREN.

Torpedo transport vessel, laid down at Copenhagen November 23, 1899; launched January 7, 1900. Length, 143 feet; beam, 25 feet; draught, aft, 10.8; drag, 2 feet; displacement, 390 tons. The engines will develop 600 i. h. p., giving a speed of 12 knots. She has Babcock & Wilcox boilers. The armament consists of three 3-pdr. R. F. guns.

ENGLAND.

DUNCAN CLASS.

This class of first-class battleships includes the following vessels, all of 14,000 tons:

Name.	Built at—	Laid down.	Launched.
Albemarle	Chatham	Jan. 8, 1900	Mar. 5, 1901
Cornwallis	Blackwall	July 13, 1899	
Duncan	do	July 10, 1899	Mar. 21, 1901
Exmouth	Birkenhead	Aug. 10, 1899	
Montagu	Devonport	Nov. 23, 1899	Mar. 5, 1901
Russell	Jarrow	Mar. 11, 1899	Feb. 19, 1901

Their dimensions are as follows: length between perpendiculars, 405 feet; beam, 75 feet 6 inches; mean draught, 26 feet 6 inches; weight of hull, 9,055 tons; displacement, 14,000 tons; i. h. p., 18,000; speed, 19 knots.

Being all built from the same plans, a single description will suffice for all of the class.

They are of steel throughout and built on the longitudinal system; the stem, sternposts, propeller-shaft brackets, and ram of massive strength are formed of steel castings. The hull is divided into 320 water-tight compartments, and there is a double bottom, extending four-fifths of the total length, under the engines and boiler-room spaces. The port and starboard engine-rooms are divided by a middle line water-tight bulkhead extending from the keel to main deck 10 feet above the load water-line. There are 3 boiler rooms, each being a separate water-tight compartment, and containing in all 24 Belleville water-tube boilers. There are longitudinal water-tight bulkheads at the sides extending throughout the machinery and boiler spaces, and subdivided by athwartship water-tight bulkheads, forming in all 52 coal bunkers, which act as an additional protection to the engines and boilers. On the platform and lower decks is placed the auxiliary machinery for the working of the ship, including electric engines, hydraulic pumping engines, capstan engines, air compressors, etc., as well as a fully equipped engineers' workshop and numerous storerooms. The officers and crew are accommodated on the middle and main decks, the admiral and captain having day cabins on the upper deck.

The officers' accommodation consists of cabins situated aft, those for the senior officers being on the main deck. The admiral's cabin is at the extreme after end of the main deck, with access to a handsome stern walk fitted with a steel canopy. The upper deck extends from stem to stern without a break, and above it are the forward and after shelter decks, on which are placed the conning towers, the latter being of 12 inch Harveyized steel and the former of 3 inch nickel-steel. These are surmounted by flying bridges and connected on each side with a fore-and-aft bridge. The boats, of which there are 18, varying in length from 13.5 to 56 feet, are stowed amidships on skid beams. The ships have two steel masts 3 feet 1 inch in diameter, each mast carrying a fighting top (with three 3-pdr. R. F. Hotchkiss guns in each) and a search-light platform. They have striking topmasts standing 160 feet above the water-line, with a truck semaphore at the main and a multiple flashing lamp at the fore. A strong steel derrick, worked by hydraulic power and tested to 36 tons lift, is fitted to the mainmast for lifting the larger boats, and the foremast is fitted with two steel derricks, each tested to 10 tons, for working the lighter boats. There are two signal yards on each mast and two smoke-pipes in a fore-and-aft line between the masts.

Loud-speaking telephones are fitted in the conning towers, connecting with the engine-rooms and the 12-in. gun positions, instead of the usual voice tubes. The helm signals are worked by Brown's telemotor gear, and electric rudder indicators are installed in the conning towers and on the bridges. Stockless anchors are provided, to stow within their own hawse pipes, and there are neither billboards nor cat davits. The ventilating cowls to the engine and fire rooms have been done away with.

The barbettes, one forward and one aft, rise from the middle deck and project a few feet above the upper deck, protected by 10 inch and 11 inch Harveyized armor, and inside are powerful hydraulic turning engines, with all the gear necessary for controlling the ponderous turntable, carrying the two 12-in. guns in a specially protected shield in each barbette. The main deck, which forms the top of the armored citadel, is a protective deck 2 inches thick, enclosing the barbettes, reduced to 1 inch thick at the stem. The middle deck, which is a protective deck of 1 inch steel, is horizontal in the center, 2 feet 6 inches above the load line, and sloped down at an angle of about 40 degrees at the sides to 5 feet below the load line, which forms the shelf on which the side armor rests, this protective deck running in this form from after to forward barbettes, of which it is the foundation; it then dips down at the center, gradually losing the angles at each side and eventually forming the lower deck, still retaining its protective thickness right to the stem casting, to which it is strongly secured. Before and abaft of the barbettes the line of this deck is continued as an ordinary deck.

The lower deck is a sloping protective deck of 1 inch thickness before the forward barbette and 2 inches thick aft of the after barbette, and protecting the steering gear, etc. The sides of the vessel are protected from stern to transverse armored bulkhead with two thicknesses of ½ inch nickel-steel on ½ inch ordinary steel plating, and from armored bulkhead to a distance of 286 feet by 7 inch Harveyized armor about 14 feet wide in wake of barbettes, reducing gradually to 2 inches nickel, which finishes in the rabbet on the stem, giving great rigidity to the powerful ram. Thus it is seen that the ends of the ship are no longer left entirely unprotected, as is the case in former classes of ships.

Behind this belt of armor coal bunkers are arranged, whereby a large amount of additional protection is secured. With a view to preventing water from finding its way below the protective deck, means are provided for closing the several openings by water-tight shutters and covers, while in the case of those which must necessarily remain open in action cofferdams have been fitted with the same object.

The ships are fitted with torpedo-net defense on each side for a distance of 300 feet from the stem.

The main armament consists of four 50-ton breech-loading guns of 12-in. caliber, with a training arc of 120 degrees each side of the middle line. These guns are of the wire-wound type and will be fitted with an apparatus by means of which each gun may be loaded at any angle of elevation or depression, either with the gun at rest or in motion. The principal advantage of this is that the guns can always be kept sighted. These guns are among the most powerful in the world, having a computed range of 20 miles. The auxiliary armament consists of twelve 6-in. R. F. guns, each placed in a casemate of Harveyized armor 6 inches thick. Four of these are on the upper deck, the two forward ones training over the bow and to 30 degrees abaft the beam, and the two after ones training over the stern and to 30 degrees before the beam. The other eight are situated on the main deck, the four forward and aft trained the same as the guns on the upper deck, and the four in the midships are trained 60 degrees before and abaft the beam. Twelve 12-pdrs., two in the bows and two on the quarters on the main deck, six in the waist of the ship on the upper deck, and two on the forward shelter deck, the latter being field and boat guns; eight Maxims on shelters and bridges, and six 3-pdrs., three in each military top. There are four submerged 18-in. torpedo tubes, two forward and two aft. The ships will carry fourteen 18-in. and five 14-in. torpedoes, the latter being for use in firing from dropping gear from the ship's steamboats. The total coal capacity is 2,200 tons, 850 tons in the upper and 1,350 tons in the lower bunkers and the wings. This amount of coal will enable the ships to steam for about thirty days at 10 knots, or about 7,200 miles.

These ships are lighted throughout by electricity, with an installation of about 900 electric lamps, and are also equipped with six search-lights of 25,000 candle-power each, the dynamos being under protection. Means are so arranged that the ships when in action can be fought from either of the two conning towers.

A departure has been made from former practice in connection with the engines, which partake more of the characteristics of the cruiser type than of the design formerly adopted in battleships. They have four cylinders, and are generally lighter. The propelling machinery is more powerful and is designed to run at a higher speed than the engines fitted to any previous battleships, being designed to develop 18,000 i. h. p. on the official eight hours' trial. For each of the twin screws there are four cylinders, viz, one high-pressure, 33½ inches; one intermediate, 54½ inches; and two low-pressure cylinders, 63 inches, all of 48-inch stroke, and designed to run at 120 revolutions per minute. The high-pressure and intermediate cylinders are placed in the middle and a low-pressure at each end. The crank shaft is in two pieces, each piece having two double-throw cranks, which have been forged solid. The body of the shaft and pins are hollow. The high-pressure and intermediate-pressure cylinders have piston valves with packing rings of the restrained type, and the low-pressure cylinders flat slide valves, with efficient relief rings on the back. The valves are all drawn by ordinary link-motion, connected with a massive weighshaft along the front of the engines. The reversing is by a continuous round-about worm and wheel gear, driven by a double-cylinder engine. Powerful hand-reversing gear is also provided, this and the steam gear being connected by clutches to the worm-shaft. All the hand gear is brought to the middle of the starting platform to give ready control with the minimum number of attendants. The propellers turn inward, and this enables the starting platform to be alongside the middle-line fore-and-aft bulkhead. Through this there is a doorway, making supervision of the two sets of engines very convenient. The engines were set up in the shops complete and ready to be placed on board as soon as the vessels were launched.

The bedplates and back standards are of cast steel, the latter being split at the bottom to get direct attachment to the girders of the bedplate. The inboard columns are turned steel forgings, their bottom ends being directly connected with six cross girders, carrying the bearings. As the cylinders are bolted together in pairs, each pair is thus supported at the back by two cast-steel standards, and at the front by three turned forged-steel columns. The cylinders themselves are, of course, of cast iron, but their pistons and covers are of cast steel. The piston and connecting rods are of substantial proportions, the bearings of the latter having large surfaces. The high and intermediate rods have to transmit each about one-third of the total power on each shaft, and are made considerably larger than those for low pressure, which have each to transmit about one-sixth. The piston rods have large shoes working on the guide plates, bolted to the back columns.

Each low-pressure cylinder has its own condenser and air pump, the latter being driven by levers from the piston-rod crosshead. As the two cylinders in each engine-room are arranged so that both low-pressure cylinders may exhaust into either one or the other alone, as well as into both together, there will be ample opportunity for keeping the tubes thoroughly clean and the condensers otherwise efficient. The air-pump discharges the water into large hot-well tanks, whence it is pumped by a large hot-well pump, of the Weir type, through grease filters into the feed tanks, to which all the feed-pump suctions are connected. Two large centrifugal pumps, with independent engines, are fitted in each engine-room for circulating the water through the condensers.

The shafting is of steel, bored hollow, the stern tube length being covered with gun-metal sleeves in one length. The propellers are four-bladed, the boss and blades being made of manganese bronze.

There are in the engine-rooms four evaporators and two distilling condensers; four fire and bilge pumps, each capable of discharging 120 tons of water per hour; four main centrifugal pumps, each capable of discharging 1,400 tons of water per hour; two auxiliary circulating air-pumps, two fans for ventilating the engine-rooms, two steering engines, two starting engines, and two turning engines. In the boiler-rooms are three main and three auxiliary feed pumps, three furnace air pumps, and ten fire-room fans. There is an ice-making machine on the compressed-air system in the forward capstan engine room, capable of making 800 pounds of ice per twenty-four hours under tropical conditions. There are four dynamos, each 480 ampères, 100 volts, two in engine rooms and two in the auxiliary machinery department, aft. By an arrangement at the switchboard any of the dynamos can be put onto any or all of the many circuits of the ship. Of the six search-lights, one is on the platform high up on each mast, and two on each bridge. There are four sets of air-compressing pumps with necessary reservoirs in the auxiliary machinery rooms, for charging and ejecting torpedoes. There are steam capstans forward, the after capstans being worked by electric motors. The steering gear is on the screw principle, and there are two steering engines, one in each engine room, having separate steam and exhaust pipes. Each engine is of sufficient power to put the rudder from hard-over to hard-over (or through 70 degrees) in thirty seconds when the ship is steaming at full speed—19 knots.

There are five positions for steering by steam, viz, forward bridge, both conning towers, lower deck forward, and steering compartment on platform deck aft, close to the wheels for steering by hand. There are twenty-four Belleville boilers, installed in separate water-tight compartments. There are two groups of eight, placed back to back, and two of four, placed back to a bulkhead. The working pressure is 300 pounds per square inch, to be reduced to 250 pounds at the engines. The boilers are fitted with economizers through which the feed water passes on its way from the feed pumps to the boilers proper or generators. The total surface of the generators and economizers is 43,260 square feet, and the grate surface 1,375 square feet. The heating surface per i. h. p. is 2.4 square feet; the i. h. p. per square foot of grate area is 13.1, and the total weight of machinery is 1,580 tons. The uptakes lead into two smoke-pipes. The boilers are fitted with automatic feed-regulators and all the usual mountings. The tubes are all solid drawn steel, and are galvanized, and the junction boxes are of malleable cast iron. In each boiler compartment there are a main and auxiliary feed pump of the Weir type, and three double-cylinder air-blowing engines for the air jets in the furnaces. Large centrifugal fans are provided for bringing a supply of air down to the fire-rooms. Steam ash-hoisting engines, with friction gearing, are also fitted. .

The main steam pipes, in fact all the steam pipes except the small ones, are of steel, and, except the large ones, are all solid drawn. The main and auxiliary steam pipes are carried from the separate boiler compartments to the engine-room bulkhead, where they join up to self-acting stop valves, from which main pipes lead to the separators, and to the main and auxiliary engines. There are separate engine-rooms provided for the engines that are not accommodated in the engine and boiler-rooms, such as air-compressing machinery, hydraulic machinery, electric-lighting machinery, etc.

A very complete workshop is also provided with a number of useful machines, such as lathes, shaping machine, punching and shearing machine, grindstones, etc., all driven by a separate steam engine. In suitable positions on the ship there will also be fitted boat-hoisting machinery, coal hoists, etc.

The complements of these ships will be about 750.

PRINCE OF WALES—QUEEN.

These new battleships were laid down March 20 and March 12, 1900, in the dockyards at Chatham and Devonport, respectively, and are to be more powerful than any battleships yet built for the English navy.

They will be 400 feet long, 75 feet beam, 26 feet 9 inches draught, of 15,000 tons displacement, 15,000 i. h. p. under natural draught, and

19 knots speed. The weight of hull, including armor and backing, will be 9,985 tons. The normal coal capacity will be 900 tons; maximum, 2,100 tons.

The armor belt will be of nickel-steel, commencing 30 feet from the bows and extending aft 220 feet. The armor will be 9 inches thick and 15 feet wide. They will have a curved bulkhead near the after barbettes made of 12 inch plates, while the barbettes themselves will be built of plates varying from 6 inches to 12 inches in thickness. A protective deck covering all the vulnerable parts has been provided for, and this will be of the turtle-back shape, having a thickness of 1 inch on the flat and 2 inches on the slopes. The barbette hoods will be of 8 and 10 inch armor, while the casemates for the 6-in. guns will be of 6 inch plates.

The armament will consist of four 12-in., 50-ton, wire-wound guns, mounted in pairs in barbettes forward and aft; twelve 6-in. R. F. guns of the latest pattern; sixteen 12-pdr. (12-hundredweight), and two 12-pdr. (8-hundredweight) R. F. guns; six 3-pdr. R. F. Hotchkiss guns, and eight 0.45-in. Maxims. They will have four submerged torpedo tubes for 18-in. Whitehead torpedoes.

There will be two sets of vertical triple-expansion engines to develop 15,000 i. h. p. The boilers will be twenty in number, of the Yarrow large-tube type in the *Queen*, and Babcock & Wilcox type in the *Prince of Wales.*

COUNTY CLASS.

This class of armored cruisers includes the following vessels, all of 9,800 tons:

Name.	Built at—	Laid down.	Launched.
Bedford	Glasgow	Feb. 19, 1900	
Berwick	do		
Cornwall	Pembroke	Mar. 11, 1901	
Cumberland	Glasgow	Feb. 19, 1901	
Donegal	do	Feb. 14, 1901	
Essex	Pembroke	Jan. 1, 1900	
Kent	Portsmouth	Feb. 12, 1900	Mar. 6, 1901
Lancaster	Elswick		
Monmouth	Glasgow	Aug. 29, 1899	
Suffolk	Portsmouth	Mar. 25, 1901	

Of these, the *Bedford*, *Essex*, *Kent*, and *Monmouth* were first authorized, the others being authorized a year later. The latter will be slightly improved over those first laid down, but only in minor details, so that the same description will apply to all of the class.

In design they are similar to the *Cressy* class in general features. Both types have all the advantage which great length affords as a contributory factor in the development of high speed, without the disadvantages which ordinarily attach to it so far as steering is concerned. At load draught the ships have a level keel for about three-fourths of their length in the central portion, and from the termination of this part at each end the keel slopes upward almost in straight lines to the stem and sternpost, the rise being considerable in both cases. This feature is designed to increase the handiness of the vessels. To further improve their steering qualities, they will be fitted with balanced rudders, which will extend as low as the deepest part of the keel, and of which a portion will work under the sloped portion above mentioned.

The principal dimensions are as follows: length between perpendiculars, 440 feet; length over all, 463.5 feet; beam, 66 feet; mean draught, 24 feet 6 inches; displacement, 9,800 tons.

They will be built of steel, unsheathed, with the high forecastle which is indispensable in a fast cruiser. The weight of the hull and armor is 5,895 tons. There will be two conning towers, one forward and one aft, and two bridges with pilot house and chart room on the forward and after ones, respectively. They will be fitted with two steel masts, each having a search-light platform. A long-distance semaphore for signaling at sea will be fitted at the head of the mainmast, and each mast will be fitted with a derrick to which can be attached a Temperley transporter for coaling purposes, the derrick on the mainmast being of steel and used for lifting out the larger boats. The boats include two steamboats, one 56 feet in length, and one 40 feet in length, and nine sailing and pulling boats, ranging from a 42 foot sailing launch to a 16 foot dingey. The two steamboats are capable of steaming about 13.5 knots per hour, and are fitted with torpedo dropping gear.

The intention of using non-inflammable wood in these vessels has been abandoned, corticine-covered steel being employed instead for the between-deck fittings. An oaken covering is being given to the quarter-decks and forecastles, as this material is much better than bare steel for the men to get about on when at sea. But no wood is being used in places where its presence is considered dangerous. Experience has proved that where wood is bolted to steel, as it is on the upper decks of these ships, it will neither burn nor splinter.

The side armor is 4 inches thick and about 11 feet deep amidships, extending in varying thicknesses right forward to the bow, and finishing well abaft the engine room at the cross-armor bulkhead. There are two protective decks, the lower one of which is of the usual turtle-back shape, on which the armor rests, and is formed of two thicknesses, each of ⅜ inch. The main deck, situated at the top of armor, also a protective deck throughout the extent of the armor belt, is composed of thicknesses of ⅝ inch plating. The length of the armor belt is 250 feet amidships, and it extends right up to the main deck. It is continued to the bow with a thickness of 2 inches. Aft it is terminated by a 5 inch bulkhead. The ram is a steel casting, weighing over 13 tons.

The armament will consist of fourteen 6-in. R. F. guns, four mounted in two low circular barbettes, forward and aft, on the upper deck on new twin mountings, in which they are trained in azimuth as one gun, but in elevation separately. The barbettes will be of special steel 4 inches thick, with floors of 2 inch steel. They will be protected by 4 inch shields. The remaining ten 6-in. guns will be carried in casemates, four on the upper deck and six on the gun deck. The four guns in the forward casemates will have a right-ahead fire, and those aft a fire right astern, leaving one gun on each side amidships in broadside. The casemate armor will be 4 inches thick.

For the barbette guns electric ammunition hoists are installed which supply ammunition to the guns alternately, but may be so arranged as to serve but one of them.

In addition to these guns there will be carried eight 12-pdr. (12-hundredweight) R. F. guns, two forward and two aft on the main deck, the others in broadside; three 3-pdr. R. F. guns; eight Maxims; and two 12-pdr. (8-hundredweight) R. F. guns carried in broadside, but also to be used for boat and field purposes. Two 18-in. submerged torpedo tubes will be fitted forward, and seven 18-in. torpedoes, besides five 14-in. torpedoes, will be carried, the latter for boat service.

It has been decided to replace the four 6-in. guns in the barbettes by two of the new 7.5-in. guns, firing 200-pound projectiles, and this will be done in the case of the later ships of this class and probably in the four first authorized as well.

They will be propelled by twin screws, each being actuated by an independent set of vertical triple-expansion engines, with one high, one intermediate, and two low-pressure cylinders, of the collective power of 11,000 i. h. p., giving an aggregate power of 22,000 i. h. p. for both sets of engines, the boiler safety valves being loaded to a pressure of 300 pounds per square inch, the steam pressure being reduced to 250 pounds per square inch at the engines. The cylinders are 37, 60, 69, and 69 inches, with 42-inch stroke.

The cylinders are of cast iron, each being a separate casting. They are braced together by wrought steel stays, fitted at the top and bottom of cylinders. Each cylinder has a separate liner forming a steam jacket. The cylinders, of course, are inverted, and are carried at the back on columns of box pattern, being made in ⅄-shape, at the bottom, to give greater stability. These columns also carry the motion bars. The front pillars are of forged steel, two to each cylinder. This arrangement leaves the front of engine open, and gives a ready access to working parts. The valves of the high and intermediate-pressure cylinders in each engine are of the piston type, while those of the low-pressure cylinders are of the triple-ported flat type. These valves are worked by double eccentric link gear, the head rod being, as usual, the straight rod. The engines are reversed by an independent double-cylinder, steam reversing-engine, working a worm and worm

CRESSY, ENGLISH ARMORED CRUISER, 12,000 TONS.

wheel of the all-round type, the clutch arrangement being fitted so that the engines can be reversed by steam or hand. The engines are balanced on the Yarrow, Schlick, and Tweedy system. There are two condensers for each engine, placed in the wings of the ship. They are of gun metal with horizontal tubes of brass, through which the circulating water passes. The cooling surface in each is 5,700 square feet. The air pumps, which are worked by levers from the low-pressure cylinder crossheads are entirely of gun metal, single acting, and are 23 inches in diameter and 21 inch stroke.

Four sets of combined engines and dynamos will be fitted to light the ship and work the electric motors and search-lights. Every compartment except the double bottom will be efficienctly lighted by incandescent lamps. Colomb's lights will be fitted for use when the dynamos are not running. Ventilation will be secured by the use of motor fans outside the engine and boiler-room spaces, and by steam fans in those compartments. There will also be a complete installation of electric bells and voice pipes, and, in addition, loud-speaking telephones at important positions.

Steam will be supplied by 31 separate water-tube boilers of the Belleville type, fitted with economizers. They contain a total heating surface of 50,300 square feet, and a grate surface of 1,610 square feet. Of the above-mentioned heating surface 17,200 square feet are in the economizers.

The boilers are arranged in three water-tight compartments, viz: 12 boilers in the after compartment, 11 in the center compartment, and 8 in the forward one. Of the six ships last ordered, all excepting the *Lancaster* will be supplied with Niclausse boilers instead of the Belleville boilers as at first proposed.

The speed on the eight hours' trial, natural draft, is to be 23 knots. The vessels, of course, are installed with the full complement of auxiliary machinery necessary for the efficient working of a first-class modern cruiser.

The amount of coal carried at normal draught is 800 tons, but provision has been made for the stowage of twice that amount.

The complement of the vessels will be 678, officers and men.

CRESSY CLASS.

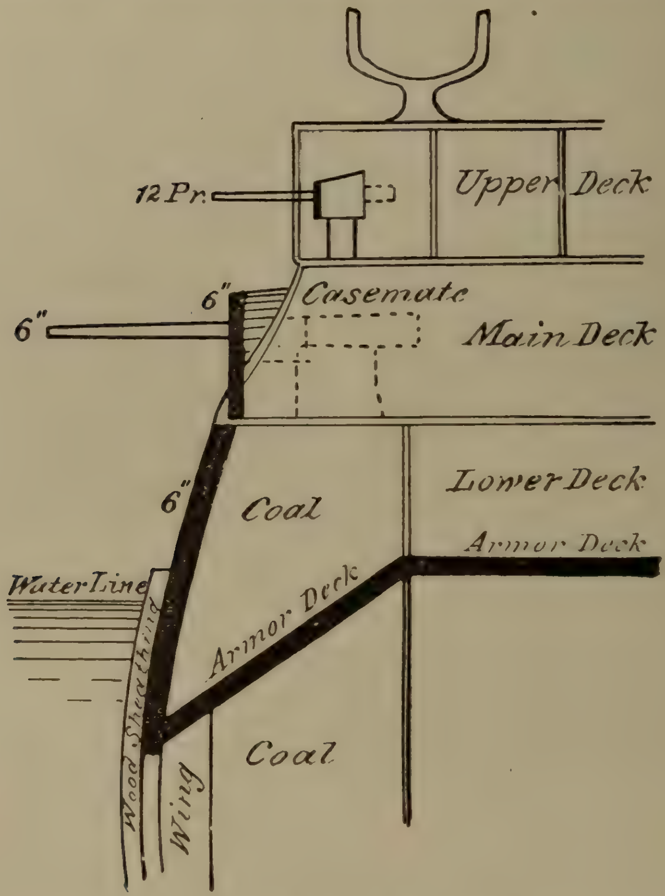
This class of armored cruisers includes the following vessels, all of 12,000 tons:

Name.	Built at—	Laid down.	Launched.
Aboukir	Glasgow	Nov. 9, 1898	May 16, 1900
Bacchante	.....do	Feb. 15, 1899	Feb. 21, 1901
Cressy	.....do	Oct. 12, 1898	Dec. 4, 1899
Euryalus	Barrow	July 18, 1899	May 20, 1901
Hogue	.....do	July 14, 1898	Aug. 13, 1900
Sutlej	Clydebank	Aug. 15, 1898	Nov. 18, 1899

Of these, the *Aboukir*, *Cressy*, and *Sutlej* have had their steam trials, which will be noted under that head. The other vessels are much in arrears.

Their general dimensions are: length between perpendiculars, 440 feet; beam, 69 feet 6 inches; mean draught, 26 feet 3 inches; displacement, 12,000 tons.

They are similar to the *Diadem* class in appearance, but built on finer lines, and the speed and stability are improved. They are sheathed with teak and coppered. The distinctive feature about them, other than the bow and stern guns, is the tumble-home of the sides. This, as the diagram shows, is very marked on the main deck. They more nearly approach the French shape of hull amidships than any other of the modern English ships. The *Diadem* class are practically wall-sided.



SECTION OF H. M. S. CRESSY.

They have two masts, each carrying a search-light platform and two signal yards, and four smoke-pipes in a fore-and-aft line.

The special characteristic of these vessels is their armor, which weighs 1,100 tons. The belt, which is coterminous with the citadel, has a length of 230 feet and a depth of 11 feet 6 inches, that is, from the main deck to 5 feet below the water line, where it joins the protective deck, thus completely inclosing the vital parts of the ship. The armor is of Harveyized steel, of a thickness of 6 inches at the belt and of 5 inches at the athwartship bulkheads at either end of the citadel. Forward of the citadel, the structure is stiffened by 2 inches of nickel steel, from the end of the belt to the stem, to support the ram and keep out small projectiles. Above the belt are the twelve 6-in. guns, which are carried in 6 inch casemates, but with no other armor protection. The deck in the wake of the citadel is of two ½ inch plates. The barbettes have 6 inch armor.

The armament consists of two 9.2-in. guns in barbettes, one forward and one aft, with 6 inch shields; twelve 6-in. R. F. guns in casemates, four on the upper deck and eight on the gun deck, the arrangement similar to that of the *County* class, the exception being that there is one additional 6-in. gun on each side; twelve 12-pdr. R. F. guns of 12 hundredweight; two 12-pdrs. of 8 hundredweight, for boat and shore purposes; three 3-pdr. R. F. guns, and eight Maxims. There will be two submerged tubes for 18-in. Whitehead torpedoes.

The propelling machinery consists of two sets of triple-expansion engines, fitted in two water-tight compartments, each set having four inverted cylinders working on four cranks. The high-pressure cylinder is 36 inches in diameter, the intermediate 59 inches, and each of the low pressure 68 inches diameter, the stroke in all cases being 48 inches. The high and intermediate-pressure cylinders are each fitted with a piston valve, and each low-pressure cylinder with a double-ported slide valve with a relieving ring at the back; all the valves being worked by the usual double-eccentric and link-motion gear. The reversing is effected by means of double-cylinder steam engines, with gear of the all-round type. Hand gear is also fitted. The crank, thrust, and propeller shafting is of forged steel and hollow. The propeller bosses are of gun metal, fitted with four adjustable blades of manganese bronze. The main condensers are at the backs of the engines and are of cast brass of oval form, fitted with brass tubes, the condensing water being supplied by four centrifugal pumps of gun metal, each fitted with independent engines. The feed, bilge, and hot-well pumps are all independent, and separate from the main engines; steam for these and all other auxiliary machinery being supplied by a special range of steam pipes. The exhaust steam will be arranged to discharge to the auxiliary condensers, the atmosphere, and low-pressure receivers. There are two auxiliary condensers, each fitted with a circulating pump and a small air pump. List and Munn's patent feed-water filters will be fitted to prevent any impurities reaching the boilers. The vessels will also be fitted with the usual auxiliary machinery, viz, a complete distilling plant to supply fresh water to the boilers, and also for drinking purposes; three sets of engines and dynamos for producing the necessary current for electric lighting; two double-cylinder direct-acting engines, with the necessary gear for steering purposes; two complete sets of air-compressing engines and pumps, with the air reservoirs for charging torpedoes, and two vertical refrigerating machines of the dense-air type, with the necessary cold-storage room for ship's provisions.

Steam will be supplied by an installation of thirty water-tube boilers having economizers, all of the latest Belleville type. The boilers are arranged in four groups, each group fitted in a water-tight compartment. They are designed to work at a pressure of 300 pounds, valves being fitted to reduce the pressure to 250 pounds at engines.

The four boiler compartments take up 130 feet of the length of the ships, the coal bunkers being arranged on either side of the fire-rooms and over the protective deck. There is also an athwart-ship bunker right forward. The boilers have been designed with most liberal steam-generating surfaces, so that no difficulty should be experienced in obtaining the full power, and even more if of any utility, and at the same time a higher power is obtained per ton of machinery than could be realized with ordinary boilers. At full power the engines will make 120 revolutions, which is estimated to give a speed of 21 knots per hour.

Pumping engines are fitted in each fire room to supply air to the furnaces and combustion chambers, and the necessary air for the fire-room ventilation will be supplied by large fans. Fans will also be fitted for the engine room and ship ventilation.

DRAKE CLASS.

This class of armored cruisers includes the following vessels of 14,100 tons:

Name.	Built at—	Laid down.	Launched.
Drake	Pembroke	Apr. 24, 1899	Mar. 5, 1901
Good Hope	Glasgow	Sept. 11, 1899	Feb. 21, 1901
King Alfred	Barrow	Aug. 11, 1899	
Leviathan	Glasgow	Nov. 30, 1899	July 3, 1901

The name originally chosen for the *Good Hope* was *Africa*, but it was changed after the ship had been ordered, as a compliment to the people of Cape Colony, who are presenting the ship to the Empire.

The vessel last named is much in arrears, and may not be launched this year.

Their general dimensions are: length between perpendiculars, 500 feet; beam, 71 feet 4 inches; mean draught, 26 feet; displacement, 14,100 tons.

These vessels are built of steel, unsheathed, and are intended to be superior to any armored cruisers in the British or foreign navies with respect to both offensive and defensive powers. The shape of the hull is to be similar to that of the *Cressy* class, as already described, including the balanced rudder. They will have two masts, each supplied with two signal yards and a search-light platform. At the fore end of the vessels is a conning tower of 12 inch armor, with an armored communicating tube to protect the gear for controlling operations throughout the ship. There are two navigating bridges, one forward and one aft.

The boiler and engine rooms occupy the middle portion of the ship below, and magazine, shell rooms, and stores of one kind and another the lower parts at the ends. Above the lower deck for a considerable distance on the fore side of the armor bulkhead the space between it and the main deck forms coal bunkers, which, when full of coal, will greatly increase the protection afforded to the vital parts below them. Underneath the lower deck, on each side, are ammunition passages, which enable the ammunition to be conveyed under protection to armored tubes which communicate between it and the casemates. The space between the lower and main decks at the fore end is occupied by storerooms, and at the after end warrant officers' cabins, pantries, etc., will be constructed.

On the main deck the officers' cabins will be built, while the crew will be accommodated forward and between the casemates, which are situated at intervals along the sides, four on each side. The casemates are in every case double-storied. They are to be formed of 6 inch Krupp armor plates in front and 2 inch plates at the sides and rear. The furnishings and fittings will be of wood, so treated as to make it non-inflammable. An electric installation is arranged for thoroughly lighting tbe vessel; also six powerful search-lights, four on the bridges and one on an elevated platform on each mast.

The armored and protected sides extend from the stem for a distance of 400 feet, enclosed aft by an armored bulkhead. The 2 inch armor is of nickel steel, extending from the lower deck to the upper deck, affording cover to the men at the 12-pdr. guns on the main deck forward. The thicker armor amidships—4, 5, and 6 inch—is all of specially hardened steel. There are two armored decks, the lower and main, the main being thicker in the wake of the citadel and forming its crown; the lower deck has sloping sides, which meet the bottom of the armor belt below the water. Abaft the citadel the lower deck form the protection over the steering arrangements and is of 2.5 inch steel. In addition, the coal bunkers are so disposed as to give protection to the machinery.

The armament of these vessels consists of two 9.2-in. breech-loading guns fitted in 6 inch armored barbettes, one forward and one aft; these are served through armored trunks from magazines and shell rooms by means of hydraulic power, as well as by hand. There are sixteen 6 in. R. F. guns, all placed in casemates of 5 inch armor, the rear walls being 2 inches thick. There are twelve 12-pdrs. distributed over the upper decks, while forward and aft on the main deck there are two 12-pdr. boat or field guns, three 3-pdrs., and nine Maxims. There are also two 18-in. submerged torpedo tubes.

The propelling machinery consists of two sets of triple-expansion engines, and will be fitted in two water-tight compartments, each set having four inverted cylinders working on four cranks. Each high-pressure cylinder is 43.5 inches, intermediate 71 inches, and low presure 81.5 inches in diameter, all adapted for a stroke of 4 feet. It is anticipated that the i. h. p. required will be obtained without difficulty with the engines working at about 120 revolutions per minute. The high and intermediate-pressure cylinders are each fitted with a piston valve, and each low-pressure cylinder with a triple-ported slide valve with a relieving ring at the back, all the valves being worked by the usual double-eccentric and link-motion gear. The engines are balanced on the Yarrow, Schlick, and Tweedy system, the many advantages of this system of balancing having been clearly proved by the perfect working of the engines of the new royal yacht *Victoria and Albert*. Reversing is effected by means of double-cylinder steam engines, with gear of the all-round type, hand gear being also fitted. The crank, thrust, and propeller shafting is of forged steel, and hollow. Each of the propellers has a boss of gun metal, with three adjustable blades of Stone's bronze. They are 19 feet in diameter and 22 feet 9 inches pitch. Each set of engines is provided with two main condensers so arranged that one condenser can be used independently of the other in case of one requiring overhaul. These condensers are used in conjunction with the main propelling machinery only, and are placed back of the engines. They are of cast brass, of oval form, fitted with brass tubes. Auxiliary condensers, one in each engine-room, fitted with independent engines and pumps are provided for condensing the steam from all the auxiliary machinery, which in vessels of this size and importance totals up to a very formidable number. The air pumps are worked direct off the main engines. The engine-rooms are exceedingly roomy and allow free access to all the moving parts.

The condensing water will be supplied by four centrifugal pumps of gun metal, each fitted with an independent engine. The main condensers have a cooling surface of 32,000 square feet, and the auxiliary condensers of 3,450 square feet. The feed, bilge, and hot-well pumps are all independent and separate from the main engines; steam for these and all other auxiliary machinery will be supplied by a special range of steam pipes. The auxiliary exhaust will be arranged to discharge to the auxiliary condensers, the atmosphere, and the low-pressure receivers, and for working the evaporators. There are two auxiliary condensers, each fitted with a circulating pump and a small air pump. List & Munn's patent feed-water filters will be fitted to prevent any impurities reaching the boilers. The vessel will also be fitted with the usual auxiliary machinery, viz, a complete distilling plant to supply fresh water to the boilers, and also for drinking purposes; three sets of engines and dynamos for producing the necessary current for electric lighting; two double-cylinder direct-acting engines with the necessary gear for steering purposes; two complete sets of air-compressing engines and pumps with the necessary reservoirs and columns for charging torpedoes, and one ice-making machine of the dense-air type, including a cold-storage room, and a pump for circulating water in the air cooler.

Steam will be supplied by an installation of forty-three water-tube boilers and economizers, all of the latest Belleville type, having a total heating surface of 71,970 square feet, and a grate surface of 2,310 square feet. The boilers will be arranged in four groups, each group fitted in a water-tight compartment. They are designed to work at a pressure of 300 pounds, the working pressure in the engine room being 250 pounds per square inch. Air is supplied to the fire-rooms by sixteen fans driven by double-acting steam engines with four air-pumping engines fitted in the fire-rooms for supplying air to the furnaces and combustion chambers. Fans will also be fitted for engine-room and ship ventilation. There will be four smoke-pipes in a fore-and-aft line, each rising 90 feet above the grate bars. The maximum coal capacity will be 2,000 tons. The total weight of machinery will be 2,500 tons. The vessels on trial are to develop 30,000 i. h. p., when a speed of 23 knots is expected to be obtained.

The complement of the ships is 900, officers and men.

COMPARISON OF THE COUNTY, CRESSY, AND DRAKE CLASSES.

The three foregoing classes of armored cruisers represent three distinct types, and it is interesting to note the essential differences, as these three types in many ways embody modern ideas, notably in having a large area of their broadsides clothed with armor. The *Kent* is taken as the representative of the *County* class.

The increased initial velocity of rapid-fire guns has so greatly increased their penetration at long range, and the havoc they may do in the interior of a ship, that dependence could no longer be placed in the protective deck and minute subdivision of the hull. At the same time the metallurgist has, by the face hardening of armor, solved the difficulty formerly experienced of allowing a sufficiency of weight for effective broadside armor protection without materially impairing the speed, which latter must always be more or less paramount in cruiser design. Originally the armor belt required was 10 inches in thickness and of necessity had to be of limited area owing to its weight. Now armor has become considerably toughened as to permit of limited thickness, and consequently extended area. The British Admiralty has therefore reduced the thickness of armor for the *Kent* class to 4 inches. The vessels are of 9,500 tons displacement. The modern cruiser is, of course, a compromise. It can not have great defensive qualities, great speed, and great gun power. One must give way in degree to the other. Because of this fact, a comparison, within certain limits, of the three typical first-class British cruisers of to-day is of interest. Thus the *Cressy* class, first laid down, has the same protection as the

Drake class, but being of less displacement something had to be forfeited in the way of speed, although the gun power remained practically the same. In the *Kent* class, again, the thickness of armor was reduced, as well as the gun power, to give better speed on a reduced displacement and cost. The *Drake* and her consorts are the largest cruisers yet contemplated, though the United States has in its present naval program cruisers of almost equal size.

CONTRAST IN DIMENSIONS AND GENERAL FEATURES.

The *Cressy* class resemble the eight vessels of the *Diadem* type, with the addition of the side armor; the *Drake* ships are belted *Powerfuls*, and the *Kent* cruisers are modifications of the *Cressy*. The last named has 6.35 feet of length to 1 foot of beam; the *Kent* rather less, because of her less displacement; and the *Drake* 7 feet to 1 foot, as will be seen by the following figures:

Class	Cressy.	Drake.	Kent.
Number ordered	Six	Four	Ten.
Length between perpendiculars	440 feet	500 feet	440 feet.
Breadth	69 feet 6 inches	71 feet	66 feet.
Draught	26 feet 3 inches	26 feet	24 feet 6 inches.
Displacement	12,000 tons	14,100 tons	9,800 tons.
Weight of hull	7,840 tons	8,500 tons	5,895 tons.
Speed in knots	21	23	23.
Indicated horsepower	21,000	30,000	22,000.
Bunker capacity (maximum)	1,600 tons	2,500 tons	1,600 tons.

The ratio of the weight of hull to the total is interesting. In the case of the *Cressy* it is 65 per cent; in the *Drake*, with her great engine power and speed, and in the *Kent*, with her reduced thickness of armor, but great speed, it is only 60 per cent. This latter approximates the results in the *Powerful*, which had a deck from 3 to 6 inches thick as the only hull protection, while in the *Diadem* class, also with a 2½ to 4 inch deck, it was 63 per cent. Thus structural modifications have been made in all three new classes to make up for any increase in the weight of armor without affecting other elements—armament, magazine accommodations, etc. In the *Cressy* class the 6 inch belt is 11 feet 6 inches wide, and in length is 230 feet, terminating 120 feet from the bow; but here the shell plating is reenforced with a belt of corresponding width of 2 inch nickel steel extending right to the ram. In the *Drake* class the belt is about 14 feet wide, and is 6 inches thick except at the fore part, where 2 inch nickel steel is again used, the total length from the stern being 400 feet, leaving about 100 feet of the broadside aft with only armored deck and subdivision protection. In the *Kent* class the same arrangement is adopted, the main belt beginning 106 feet from the stern. It is 4 inches in thickness, tapering to 2 inches at the bow; its width is as in the *Cressy*. We have thus 80 per cent of the length of the *Cressy* and *Drake* protected on the broadside, and 76 per cent of the length of the *Kent*. In the later ships there is only an armored bulkhead aft where the main belt terminates, and it is 5 inches thick in the *Cressy*, 12 inches in the *Drake*, and 4 inches in the *Kent*. As with all British armored ships now, there are two protective decks—the lower and main, the latter being thicker within the citadel to form its crown. The thickness in the larger cruisers is from 3 to 2 inches, and generally 2½ inches abaft the main side armor.

And now as regards the armament. The *Drake* class has greater gun power than any previous cruiser, for not only is there an increase in number, but many of the guns are of the Vickers type, developing greater velocity and having more penetration than the weapons formerly used. There are in this class two 9.2-in. breech-loading guns fitted in 6 inch armored barbettes (one forward and one aft). These are served through armored trunks from the magazines and shell rooms by means of hydraulic power, as well as by hand. There are sixteen 6-in. R. F. guns (four more than in the *Powerful*) all placed in casemates of 5 inch armor, the rear walls being 2 inches thick. Of the smaller rapid-fire guns there are twelve 12-pdrs. distributed over the upper decks, while forward and aft, on the main deck, there are two 12-pdr. boat or field guns, three 3-pdrs., and nine Maxims. There are also two under-water 18-in. torpedo tubes. The principal difference in the case of the *Cressy* is that there are only twelve 6-in. R. F. guns, and in the *Kent* class there are four 6-in. R. F. guns mounted in pairs in 4 inch armored barbettes, instead of the two 9.2-in. breech loaders, one forward and one aft. There are in the *Kent* class ten 6-in. R. F. guns in 4 inch armored casemates, ten 12-pdr. R. F. guns, three 3-pdr. R. F. guns, eight .45-in. Maxims, with two 18-in. submerged torpedo tubes.

DETAILS OF THE MACHINERY.

Taking up the subject of the machinery, the leading particulars follow in tabular form and afford an interesting comparison.

	Cressy.	Drake.	Kent.
Cylinders:			
High pressure ....inches..	36	43½	37
Intermediate pressure ....do...	59	71	60
Low pressure, two ....do...	68	81½	69
Stroke ....do...	48	48	42
Revolutions	120	120	140
Piston speed..........feet..	960	960	980
Working pressure..........pounds..	300 to 250	300 to 250	300 to 250
Number Belleville boilers..........	30	43	31
Heating surface..........square feet..	51,500	71,970	50,300
Grate area ....do...	1,650	2,310	1,610
Weight of machinery ....tons..	1,800	2,500	1,750
Indicated horsepower per ton..........	11.67	12.00	12.56
Square feet of heating surface per indicated horsepower	2.45	2.4	2.29
Indicated horsepower per square foot of grate area..........	12.7	13.0	13.65

It is not necessary to enter here into details as to the design of the machinery, as that has been fully treated of in the foregoing articles. The high piston speed is one result of the importance of keeping the engines completely under the protective deck, and in action these will, as far as possible, be inclosed within cofferdams. The ratio of cylinders can easily be arrived at from the particulars given. In the case of the *Kent*, for instance, high pressure to low pressure, it is 6.96, and pressure in the intermediate is to be reduced to 49.5 pounds. The reduction in the weight of machinery to 12.56 i. h. p. per ton in the case of the *Kent* is interesting. This has been exceeded in the trials of some of the recent ships, and 2.29 square feet of heating surface per unit of power, although less than in recent cruisers, is liberal when comparison is made with the boilers of the cylindrical type worked under forced draft, so that the high result is got without unduly forcing the boilers.

CHALLENGER AND ENCOUNTER.

These second-class protected cruisers were laid down at Chatham December 1, 1900, and Devonport January 28, 1901, respectively. They are to be an improvement on the *Hermes* type, and as they are to be a knot faster—which calls for an increase in power—they are to be of greater displacement, and the dimensions are altered so as not to increase the draught.

The dimensions are: length, 355 feet; beam, 56 feet; mean draught, 21 feet; displacement, 5,880 tons.

They will be built of steel, with an armored protective deck and heavily armored conning towers, and with a view to being able to keep out of dock for long periods, the hull will be sheathed and coppered.

The armament will consist of eleven 6-in. R. F. guns, nine 12-pdr. R. F. guns, eight of 12 hundredweight, and one of 8 hundredweight, for boat and field purposes; six 3-pdr. R. F. guns, and six Maxims. They will have two submerged torpedo tubes for discharging 18-in. Whitehead torpedoes, and will carry seven torpedoes.

The engines are designed to develop 12,500 i. h. p. and maintain a speed of 21 knots.

Belleville boilers were ordered for these ships, but the orders have been canceled, and they are to be fitted with 18 Dürr boilers similar to those in use in the German navy.

The complement will be 475, officers and men.

ESPIÈGLE CLASS.

These new sloops are an improvement over the *Condor* class of sloops, being somewhat stronger and faster. The following vessels of this class have been laid down, and it is probable that the two sloops proposed in this year's estimates will be of the same class:

Name.	Built at—	Laid down.	Launched.
Espiègle	Sheerness	Jan. 8, 1900	Dec. 8, 1900
Fantome	do	do	Mar. 23, 1901
Merlin	do	Feb. 11, 1901	
Odin	do	do	

Their general dimensions are: length, 185 feet; beam, 33 feet; mean draught, 11 feet 3 inches, and a displacement of 1,070 tons.

They have steel frames, covered with steel plating ¼ inch thick, which is sheathed with wood 4 inches thick to a height of 2 feet above the load water-line, and coppered. The copper sheathing extends to 1 foot above the load water-line. The ships are minutely divided into water-tight compartments, while above the engine and boiler-rooms runs a steel water-tight deck, which forms a division between the upper and lower coal bunkers. They will be barked-rigged, and fitted with hand-steering gear and electric search-lights. The weight of hull is 540 tons.

The armament will consist of six 4-in. R. F. guns, two forward, two aft, and two amidship; four 3-pdr. Hotchkiss R. F. guns, and two Maxims.

They will have vertical triple-expansion engines, driving twin screws, and with an i. h. p. of 1,400 are expected to make 13 to 13.25 knots per hour.

They will be supplied with Babcock & Wilcox boilers. The bunker capacity will be 160 tons.

The complement will be 113, officers and men.

MOORHEN AND TEAL.

These two shallow-draught gunboats were ordered in October, 1900, and the *Teal* was launched, with steam up, May 18, 1901. They are similar to the *Heron* class, described in General Information Series No. XVIII, page 88, but larger.

In building these vessels the problem was to carry a load, consisting of fuel and armament, of 40 tons on a draught of 27 inches; to have all the vulnerable parts of the vessels plated so as to be proof against rifle fire, and at the same time to attain a speed of 13 knots under forced draft, burning wood fuel only. They are intended for use on the rivers in China.

Their dimensions are: length, 160 feet; beam, 24 feet 6 inches; draught, 27 inches; displacement, 180 tons.

The armament consists of two 6-pdr. R. F. guns and four 0.45-in. Maxims.

The vessels have twin screws and compound engines, which are to develop 800 i. h. p. with forced draft. They are fitted with two Yarrow straight-tube water-tube boilers.

During the last week in May, 1901, the *Teal* had her official trials at the mouth of the Thames, which were highly gratifying to all concerned. On a continuous run of some hours' duration the contract speed of 13 knots was attained with exceptional ease, with natural draft only and wood fuel, the draught being but 26.25 inches.

KANGAROO AND SYREN.

These torpedo-boat destroyers were launched from the Jarrow shipyard of Palmer's Shipbuilding Company September 8, 1900, and December 20, 1900, and are the fourteenth and fifteenth vessels of a similar type built at that yard.

Their dimensions are: length over all, 219 feet 6 inches; length on the load water-line, 215 feet; beam, 20 feet 9 inches; depth, 12 feet 10½ inches; mean draught, 5 feet 7 inches; displacement, 370 tons; guaranteed speed, 30 knots.

The armament consists of one 12-pdr. R. F. gun, three 6-pdr. R. F. guns, and two 18-in. torpedo tubes.

They have two triple-expansion engines and four Reed's water-tube boilers.

RACEHORSE AND ROEBUCK.

These torpedo-boat destroyers were launched at Newcastle November 8, 1900, and January 4, 1901, respectively, and are of a type similar to the *Kangaroo*, the dimensions being: length, 210 feet; beam, 21 feet; depth, 12 feet 6 inches; displacement, 360 tons.

The armament will be one 12-pdr. and five 6-pdr. R. F. guns and two deck torpedo tubes for 18-in. torpedoes.

The main propelling machinery will consist of two sets of vertical triple-expansion engines of specially light design, in the construction of which steel and the strongest bronze alloys have been most extensively used with a view of getting the maximum strength from the least possible weight. The engines when working at full power will run about 390 revolutions per minute and should develop fully 6,000 i. h. p. Steam is to be supplied by four Yarrow water-tube boilers, designed for a working pressure of 250 pounds per square inch and arranged in two separate water-tight compartments.

NOS. 98, 99 AND 107.

These torpedo boats of a new and improved type were launched at Chiswick January 22, March 5, and July 2, 1901, respectively, and are the first of four 25-knot torpedo boats being built for the English navy. The remaining one will be numbered 108.

These vessels, when completed, will be the most powerful torpedo boats in the world, as they will have a greater armament than any others, and will develop the high speed of 25 knots with a full load of 42 tons.

It is interesting to compare the dimensions of these vessels with those of No. 1 torpedo boat (the *Lightning*), completed by Messrs. John I. Thornycroft & Co. in 1877, the latter being armed with one 14-in. torpedo tube only and no guns:

	Nos. 98, 99 and 107.	No. 1 torpedo boat, Lightning.
Length	155 feet	84 feet 7 inches.
Beam	17 feet	10 feet 10 inches.
Draught, maximum	8 feet 5 inches.	5 feet.
Displacement	150 tons	30 tons.
I. H. P	2,800	400.
Speed	25 knots	18.55 knots.

The larger size, necessary for the increased speed, of the new vessels, compared with the earlier torpedo boats, will enable them to maintain their speed even in rough weather better than their predecessors did in smooth. The engines are of the Thornycroft balanced type, which have proved so free from vibration and have worked so successfully in the destroyers built for the British and other governments. The vessels will be armed with three 3-pdr. R. F. guns and three torpedo tubes for 18-in. Whitehead torpedoes.

SUBMARINE BOATS.

Mention has been made of five submarine boats building for the English navy. The following particulars regarding them are available. Dimensions: length, 63 feet 4 inches; beam, 11 feet 9 inches; displacement when submerged, 120 tons.

The plating and frames are to be of steel, of sufficient size and thickness to withstand the pressures at depths not over 100 feet. Bulkheads are to be located to provide safety in the event of collision and to stiffen the hull as a whole. The superstructure is to be located to allow of an above-water deck 31 feet long when the vessel is light for surface running. The conning tower will be of armor steel, having an outside diameter of 32 inches and a minimum thickness of 4 inches, and provided with ports for observation.

In addition to the ports the vessels will be lighted by incandescent electric lamps.

Compressed air will be stored aboard, and ventilators will be provided for the circulation of outside air through the vessel. A positive exclusion of gasoline vapors from the interior of the boat will be possible, and safety valves will be provided to relieve any excess of pressure in the vessel over that of the atmosphere.

The armament will consist of one torpedo-expulsion tube, located at the extreme forward end of the vessel, opening outboard, 2 feet below the light water-line. The vessels will have capacity for carrying 5 torpedoes, each 11 feet 8 inches long.

The vessels are to be provided with a means for expelling torpedoes while in the following conditions and positions: At rest or during run on the surface; before or after submergence; while awash, at rest, or at full speed, with a sufficient portion of the conning tower emerged to allow observation by the navigator while running submerged. All the necessary appliances will be installed to make certain and safe the accomplishment of these conditions.

The main engines will be of gasoline type for surface propulsion and of 160 i. h. p. The fuel supply will allow of a maximum run of about 400 knots. The maximum speed on the surface will be about 9 knots per hour. The main motor will be of the electric waterproof type, giving the vessel a speed of 7 knots when submerged. The storage battery will have a capacity for a four hours' run at 7 knots.

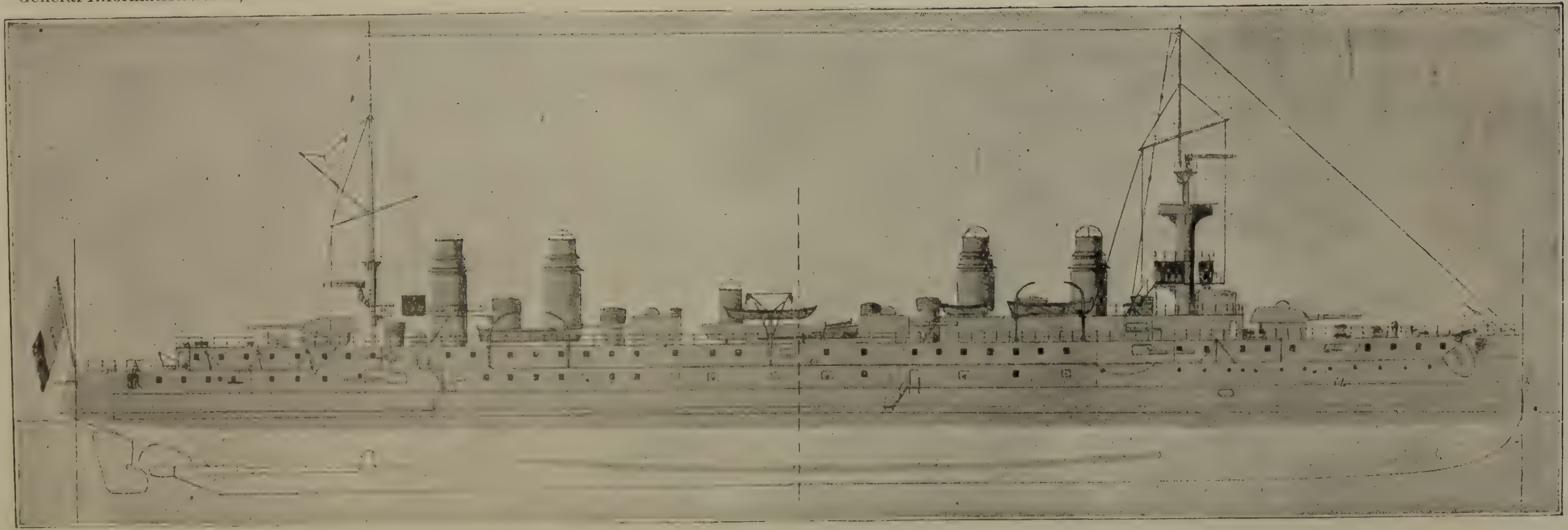
The engines will be provided with automatic means of moving the rudders to the desired positions, and automatic means to prevent the vessel inclining to excessive angles during diving or rising, to keep the depth of submergence constant, to bring the vessel to a horizontal position at the desired depth, and to prevent diving to excessive depths. Both steering and guiding are to be produced by hand gear if desired.

In diving, the boat will be submerged to an awash condition, with only the conning tower ports above water, then dive at a small angle until the proper depth is reached, when, through automatic or hand-operated means, the boat is brought to a horizontal position. After the discharge of the torpedo from the fixed bow tube, the compensation for the weight of the torpedo expended is automatic and almost instantaneous, causing only a slight change of trim for a few seconds. Provision is to be made for quick rising and diving for observation, the time for the appearance of the conning tower above water being dependent upon the skill of the navigator.

The official trial will consist of a surface run of 10 miles at 7 knots and a submerged run of 2 miles at 7 knots. At the end of the submerged run, a service torpedo will be discharged and strike a target 150 feet long by 16 feet deep, the upper edge of the target being awash and placed at right angles to the course. During the submerged run the boat will not come to the surface more than three times from the time of starting until the discharge of the torpedo, the duration of each appearance not to exceed one minute. Suitable masts are to be provided for observation of the boat's movements while submerged.

ASSISTANCE.

A new departure for the English navy is the building of the repair ship *Assistance*. Her dimensions are: length, 436 feet; beam, 53 feet; draught, 20 feet; displacement, 9,600 tons. Her engines, with Howden's system of forced draft, will develop 4,200 i. h. p., giving a speed of 13 knots, while with natural draft the power is 3,000 and



SULLY (CONDÉ CLASS), FRENCH ARMORED CRUISER, 10,000 TONS.

the speed 12 knots. The vessel will cost $382,000, and the machine tools with which she will be equipped will cost $390,000.

FRANCE.

PATRIE AND RÉPUBLIQUE.

Two new battleships for the French navy, authorized by the law of 1901, have been ordered to be built, and to them have been assigned the names *Patrie* and *République*. They will be the largest vessels in the French navy.

Their dimensions are: length, 439 feet; beam, 79 feet; draught, aft, 27 feet 5 inches; displacement, 14,865 tons.

The protection comprises a complete belt 11.8 inches thick, a thinner belt 3.15 inches thick, protecting the gun deck, a lower protective deck 2.75 inches thick, and an upper protective deck 2.15 inches thick. The main armament will be protected by armor 11.8 inches thick, and the turrets of the auxiliary battery by armor 5.5 inches thick, as will also be the armored redoubts.

The armament will consist of four 12-in. guns in two turrets, forward and aft, eighteen 6.5-in. R. F. guns, of which twelve will be in six turrets and six in armored redoubts; twenty-six 3-pdr. R. F. guns; two 1-pdr. R. F. guns, and five torpedo tubes, two submerged.

There will be three vertical triple-expansion engines and three screws, of a combined power of 17,475 i. h. p. The mean speed will be 18 knots.

Steam will be supplied by multitubular boilers, and there will be a coal supply of 1,825 tons, giving a radius of action of 1,880 miles at full power, and 8,390 miles at 10 knots.

The complement will be 42 officers and 751 men.

CONDÉ CLASS.

These armored cruisers comprise the following vessels of 10,000 tons:

Name.	Built at—	Laid down.	Launched.
Amiral Aube	St. Nazaire	—— —, 1899	
Condé	Lorient	Apr. 1, 1901	
Gloire	do	Sept. 5, 1899	June 27, 1900
Marseillaise	Brest	Jan. 10, 1900	July 14, 1900
Sully	La Seyne	June —, 1900	June 4, 1901

Their dimensions are: length between perpendiculars, 452 feet 10 inches; beam, 66 feet 3 inches; mean draught, 24 feet; displacement, 10,000 tons.

They are built of steel, with slight ram bow; 1 military mast forward with 2 tops, and a signal mast aft; 4 smoke pipes in a fore-and-aft line, 2 just abaft foremast and 2 forward of mainmast, each pair about the middle of the two halves of the vessel.

The vessels are protected by three stages of armor. Along the water-line there is an armor belt extending from the stem to within 13 feet of the stern, where it is ended by a transverse bulkhead. This belt extends from 2.1 feet above the water line to 4.4 feet below it forward and amidships, tapering to 2 feet below the water-line at the after end. The thickness is constant from the upper edge to 1.6 feet below the water-line, and is 3.5 inches forward, 6 inches amidships, and 3 inches aft. At the lower edge the thicknesses are 2, 2.75, and 2 inches, respectively.

Above this belt, and over the same extent, there is a belt protecting the main deck, and rising as high as the upper armored deck. Its thicknesses at the upper and lower edges, respectively, are 3.15 and 3.6 inches forward, 4.7 and 5.1 inches amidships, and 2.75 and 3.15 inches aft.

Above this, and for a distance of 131 feet from the bow, there is a belt protecting the gun deck which is 1.6 inches thick, between the spar deck and the main deck belt.

The horizontal protection consists of two armored decks.

The lower one has a nearly flat surface in the middle line of the vessel, and is 1 inch thick. The highest part is level with the upper part of the main belt, and it inclines downward to the side to meet the lower edge of the main belt, the thickness on the slopes being 1.75 inches.

The upper protective deck, which is at the upper edge of the second belt forming the gun deck, is of steel, 0.4 inch in thickness as far as the after end of the upper armor, and from there to the stern bulkhead it is reenforced by plates 1 inch thick.

The two 7.6-in. guns are in balanced barbette turrets, the platforms supporting the guns carrying armored cupolas. The armor is as follows: Of the movable part, walls 8 inches, cupola 1.1 inches, splinter shields 1.5 inches; fixed part, parapet 8 inches, deck 1.5 inches, upper part of armored ammunition hoist 6.3 inches, lower part 2 inches.

The 6.5-in. guns are installed, four in turrets on the upper deck and four in casemates, two on the gun deck forward and two on the main deck aft. Turrets, vertical walls in front 4.7 inches, side 3.9 inches, cupola 1.2 inches, splinter shield 1.5 inches, fixed base of turrets 4.7 inches, deck 1.5 inches, upper part of ammunition hoist 3.1 inches, lower part 2 inches. The forward redoubts are sponsoned out slightly. The sides of the after redoubts are vertical from the upper edge of the main belt. They are protected as follows: Transverse bulkhead, abaft forward and forward of after redoubts, 3.9 inches, fronts of redoubts 4.7 inches, roof of redoubts 0.85 inch internal walls 3.1 inches, deck 1.2 inches. The after bulkhead, which limits the middle and main belts, is 3 inches thick at bottom and 1.6 inches at the top. The conning tower is elliptical in shape, and has 8-inch armor on forward part and 6.5 inches on after part, roof 1.2 inches thick. The armored tube for voice pipes, etc., is 3.9 inches thick. Protection is also obtained by the cellular subdivision of the space between the two protective decks, by four longitudinal water-tight bulkheads, thus forming five sections. The outer section on each side constitutes a cofferdam, divided into numerous water-tight compartments filled with water-excluding material, the next section on either side being two wing passages, and the inner section is divided into many compartments, and the smoke pipes, ventilators, ammunition hoists, etc., pass up through it, being protected at their bases by cylinders of armor.

The armament consists of two 7.6 in. guns each in a barbette turret, forward and aft, having an arc of fire of 270 degrees. The elevation is obtained by hand, lateral train by hand or electricity. Two distinct ammunition hoists are installed, one for shell, one for powder.

Eight 6.5-in. R. F. guns, mounted as already described, and each provided with electric ammunition hoists; six 4-in. R. F. guns, two on gun deck above the after 6.5-in. guns, two on spar deck above the forward 6.5-in. guns, and two on gun deck amidships. These all carry splinter shields which completely close the openings of the ports. Eighteen 3-pdr. R. F. guns, four in the tops, four on the bridges, and the remaining ten in broadside on main deck. Six 1-pdr. R. F. guns and two 9-pdr. boat and field guns.

Two submerged and three above-water torpedo launching tubes.

The motive apparatus consists of three vertical triple-expansion engines in separate compartments, each actuating a single screw. The normal i. h. p. is 10,000, maximum 20,500, giving 138 revolutions per minute and a speed of 21 knots. The auxiliary engines are very numerous, for ammunition hoists, pumps, ventilators, dynamos, etc., without counting the auxiliary apparatus proper of the engines.

There are four dynamos, each giving 800 ampères at 82 volts, run by direct connected compound engines at 350 revolutions per minute. There are six 24 inch search-lights.

The boilers are of the Belleville type in the *Amiral Aube* and *Sully*, Niclausse type in the *Condé* and *Gloire*, and multitubular in the *Marseillaise*. They are twenty-eight in number in four separate compartments, six in the end compartments and eight in the amidships compartments. The engines are in the center of the ship with fourteen boilers forward of and abaft them. There are 352 elements, with 18 tubes in each. Total grate surface 118.4 square feet, heating surface 39,904 square feet.

The coal capacity at mean load draught is 970 tons, maximum

1,600 tons; radius of action at maximum speed, full coal supply, 1,940 miles; at 10 knots, 10,400 miles. They have cisterns to carry 80 tons of petroleum in addition to the coal supply.

The complements are 23 officers and 540 men, the first and last to have 30 officers and 584 men, being arranged to be used as flagships.

DESAIX AND KLÉBER.

Of these armored cruisers of 7,700 tons building at St. Nazaire and Bordeaux, respectively, the first was launched March 21, 1901.

They are described in General Information Series No. XIX, page 61.

The armament is not to be carried as shown in the plan at page 297 of No. XVIII, but will be disposed as in the plan herewith shown, and will be composed of the following: Eight 6.5-in. R. F. guns, coupled on four turrets, one forward, one aft, and one on each broadside, the walls of the superstructure being curved inward so as to carry the two turrets without the necessity of having sponsons for them; four 4-in. R. F. guns on the main deck at the four corners of the superstructure; six 3-pdr. R. F. guns and four 1-pdr. R. F. guns on the upper deck. It was at first intended to carry four more 3-pdrs, two on each side on the lower deck, but these guns have been suppressed. The only guns having protection are those in the turrets, neither casemates nor shields being supplied to any of the others. There will be two torpedo tubes.

A change has also been made in the armor belt, which now is carried without change in thickness to the deck above the protective deck, making it 7 feet 3 inches above the water line, and it is carried about as far aft as formerly described. The after ends of the two belts are joined by an athwartship curved bulkhead on the lower deck which incloses the ammunition hoists of the guns in the after turret and entirely incloses the "tranche cellulaire."

GUEYDON AND MONTCALM.

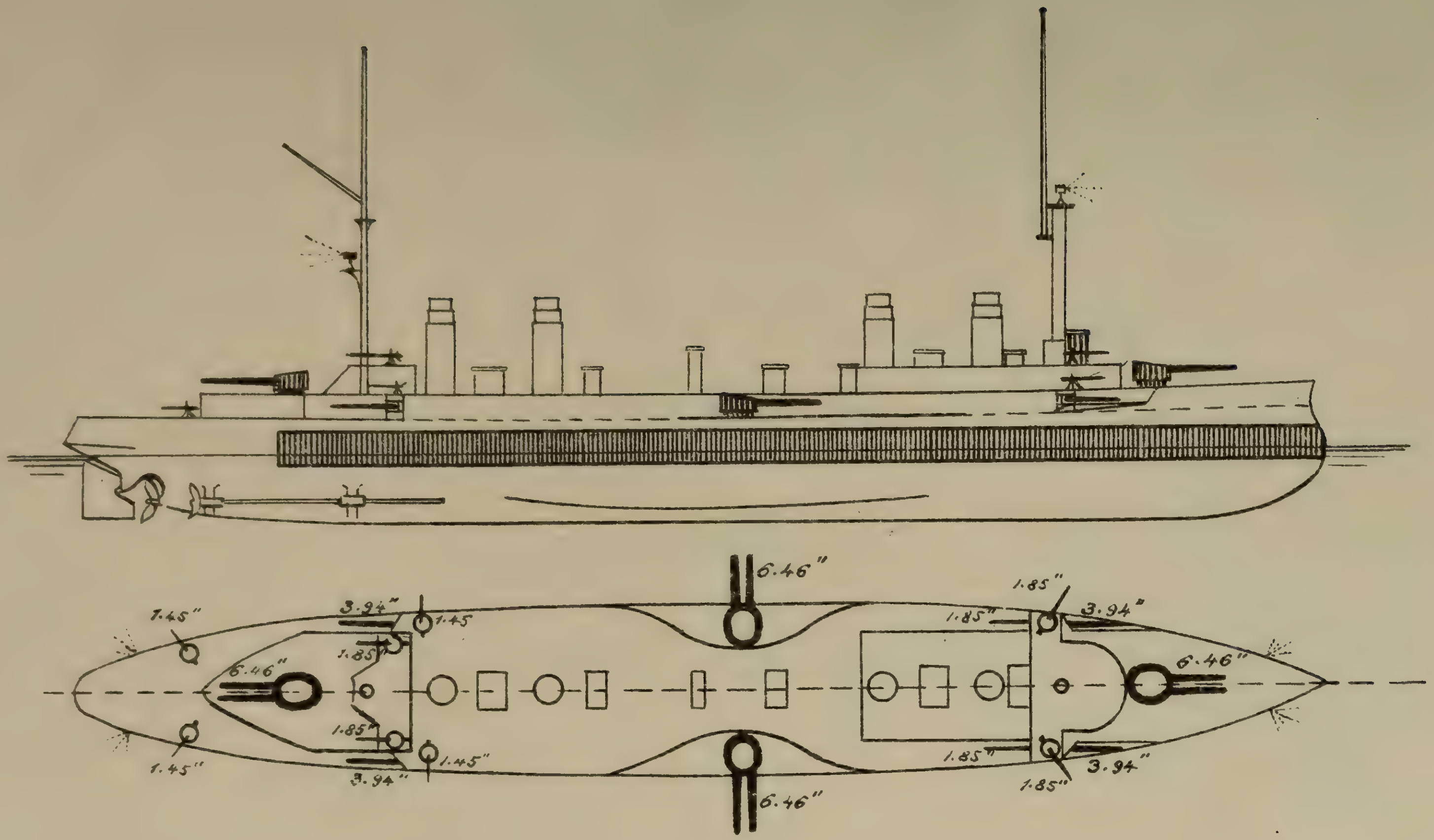
These armored cruisers, now completing, are described in General Information Series No. XIX, page 63. Their dimensions are: length, 452 feet 9 inches; beam, 63 feet 8 inches; mean draught, 24 feet 6 inches; displacement, 9,500 tons.

JEANNE D' ARC.

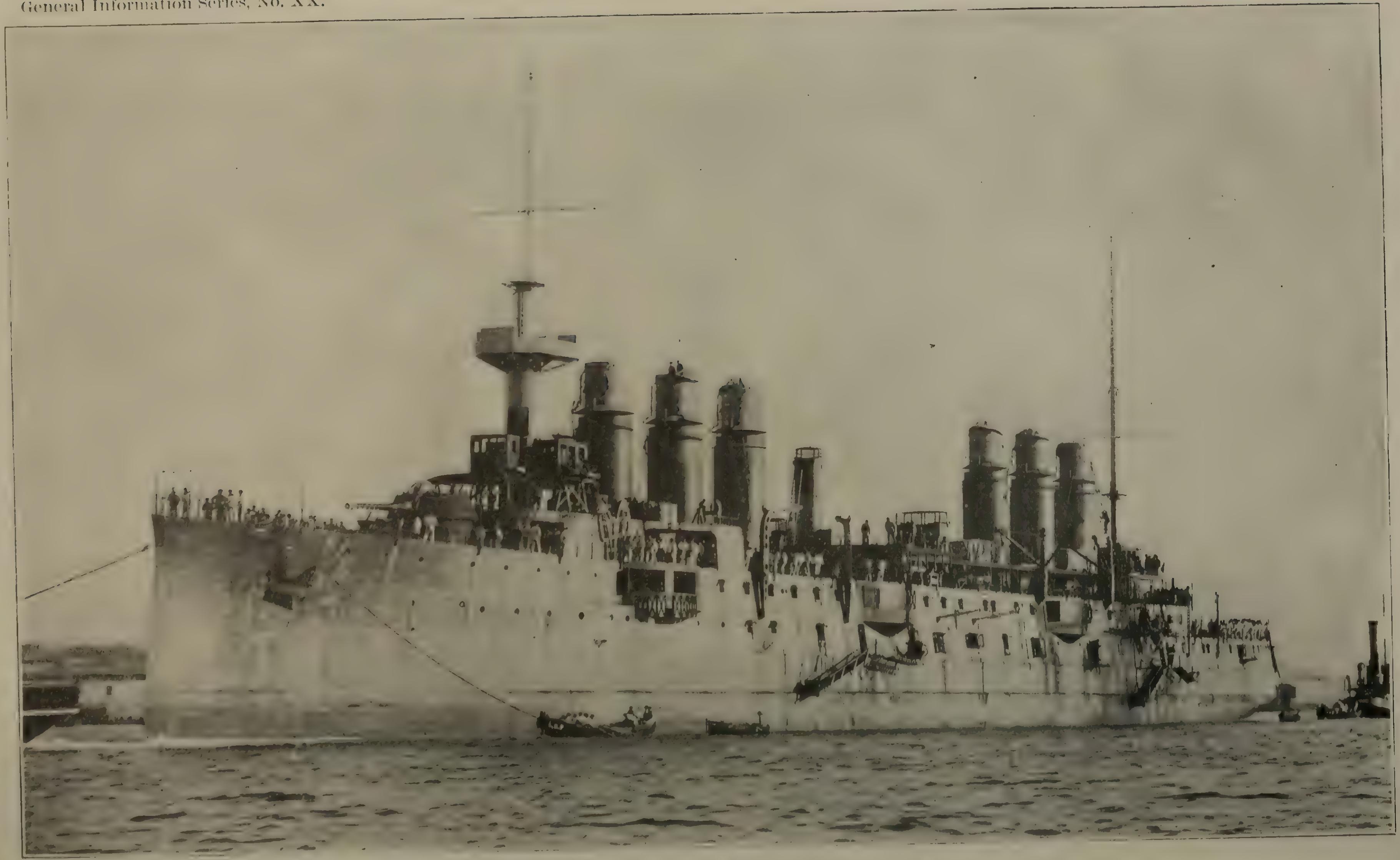
This armored cruiser was laid down at Toulon October 24, 1896, and launched June 8, 1899, and is now about to have her steam trials.

Her dimensions are: Length, 477 feet; beam, 63 feet 8 inches; draught, 26 feet 8 inches; displacement, 11,270 tons.

She has a very slight ram bow, two masts, with a military top in the forward one, and six smoke-pipes, in a fore-and-aft line, in two groups



DESAIX, FRENCH ARMORED CRUISER, 7,700 TONS.



JEANNE d'ARC, FRENCH ARMORED CRUISER, 11,270 TONS.

of three each. The armored casings of the after ones are much lower than those of the forward ones, said to be to increase stability. The spar deck is carried aft to the mainmast where it ends, and the after part is one deck lower. A superstructure reaches from the foremast to the forward smoke-pipe of the after group. There are three sponsons on either side on the main deck.

The protection consists of a complete belt, 6 inches thick from the water line to the top, which is 2 feet 4 inches above the water line. It extends 5 feet below the water line, diminishing in thickness toward the bottom and toward the ends of the ship. Above this belt is another which extends to the upper armored deck, about 8 feet wide and 3 inches thick. For a distance of about 115 feet aft from the stem this armor is carried to the upper deck. There are two armored decks. The lower one is just above the water line amidships, and slopes at the sides to meet the lower edge of the belt, being 2.5 inches on the flat and 3 inches thick on the slopes. Forward and aft it slopes down below the water line on the center line of the ship. Above this is a second armored deck 1 inch thick at the level of the upper edge of the upper belt. The main belt is secured on teak backing. Within this there is a cofferdam fitted with water-excluding material, and within this a water-tight bulkhead extends around the ship, having numerous water-tight doors, forming a wing passage, giving access to the cofferdams, and localizing any water that might enter through breaches in the armor. There are sluices to carry this water to the bilges when it is desirable to pump it out. Between these water-tight bulkheads and the two armored decks is the "tranche cellulaire," greatly subdivided and used for the storage of coal, water, etc. All the ammunition hoists, smoke pipes, ventilating pipes, etc., passing through this space are provided with cofferdams throughout the space, and also with armored coamings at their bases. There is a large superstructure extending from amidships to the foremast, where the conning tower, pilot house, and bridge are placed.

The armament consists of two 7.6-in. guns in turrets forward and aft; the turrets are 8 inches thick above the deck, and 6.5 inches thick below it; fourteen 5.5-in. R. F. guns, four in casemates near the turret guns, six in sponsons, and the remainder on the upper deck, all protected by 3 inch armor; sixteen 3-pdr. R. F. guns on the upper deck and forward superstructure; six 1-pdr. R. F. guns, and two 18-in. submerged torpedo tubes.

The installation of the magazines was a source of difficulty on account of the large space occupied by the propelling machinery, nearly three-quarters of the length of the ship in the central part. The magazines for the 7.6-in. guns are below the turrets at the two extremities of the engine and boiler-rooms. The other magazines for the intermediate and small-caliber guns, are under the protective deck in the wake of the boiler-rooms alongside the coal bunkers, and above the transverse compartment for the torpedo tubes, which is placed between the forward fire-rooms and the engine-rooms. All these magazines communicate with each other by means of a corridor outside the engine and boiler-room longitudinal bulkheads. The two corridors, starboard and port, communicate with each other at their extremities through the 7.6-in. magazines, and in the center by those placed above the torpedo rooms. A railway provides for the transport of ammunition from one end of the ship to the other. This arrangement facilitates and assures the ammunition supply, as each gun can be supplied from any magazine. The ammunition hoists are worked by electricity.

There are three vertical, four-cylinder, triple-expansion engines, actuating three four-bladed screws. The engines are in separate compartments, and the air and circulating pumps and condensers are in compartments distinct from the engines. With forced draft the collective i. h. p. of the engines should be 28,500, and the speed 23 knots.

Steam is supplied by 36 multitubular boilers on the Du Temple-Guyot system. These are arranged in two groups forward of and abaft the engines. Each group is disposed in three compartments, having two athwartship fire rooms in each, from which three boilers are fired. One smoke-pipe rises from each of these compartments. The total grate surface is 1,636 square feet. The normal coal supply is 1,400 tons, maximum 2,100 tons. The radius of action at full speed is 2,000 miles, and at 10 knots, 13,500 miles. Provision is made for the use of liquid fuel, both as to storage and consumption.

Electric power is used for ventilating machinery and many of the auxiliaries. Four dynamos are provided, and there are six searchlights, one in the foretop and one on the mainmast, the remainder on the superstructure and bridges.

The complement will be 40 officers and 586 men.

JULES FERRY, LÉON GAMBETTA, AND VICTOR HUGO.

Of these new armored cruisers the first two were ordered in July, 1900, at Cherbourg and Brest, while the third was ordered in March, 1901, having been authorized by a later enactment.

Their dimensions are: length, 480 feet 8 inches; beam, 70 feet 2 inches; mean draught, 26 feet 10 inches; displacement, 12,550 tons (metric). In general features and armored protection they will resemble the *Condé* class, already described, but will carry two guns in each turret instead of one.

The armament will consist of four 7.6-in. guns in two turrets, one on upper deck forward, and the other aft, one deck lower, the upper deck ending just abaft the mainmast, leaving the after part of the ship lower than the forward part; sixteen 6.5-in. R. F. guns, of which twelve will be in six turrets on the upper deck, three on each side about equally spaced between the two 7.6-in. turrets; two will be in armored casemates forward on the gun deck, just abaft and one deck below the 7.6-in. turret, and two in armored casemates on main deck somewhat forward of and one deck below the after 7.6-in. turret; twenty-two 3-pdr. R. F. guns in broadside on main and gun decks, and on bridges, and two 1-pdr. R. F. guns. There will be five torpedo tubes, of which two will be submerged.

They will have three vertical triple-expansion engines actuating three screws. The maximum i. h. p. will be 27,500, and speed 22 knots.

The boilers will be of the multitubular type, and will be placed both forward of and abaft the engines, which is the practice in modern French vessels.

The coal capacity will be 2,100 tons, giving a radius of action of 12,000 miles at 10 knots speed, and 1,590 miles at full speed.

The complement will be 38 officers and 690 men.

These vessels are to cost $5,593,622.50, of which $776,171.40 is for armament and $66,334.10 for torpedoes.

In December, 1900, fire destroyed one of the buildings at the Cherbourg arsenal, where the *Jules Ferry* is to be built, and with it the plans upon which she was to be built, so they will have to be redrawn, which will delay her progress somewhat.

ARGUS AND VIGILANTE.

These light-draught gunboats were built by Thornycroft & Co., and sent to China in sections and there put together.

Their dimensions are: length, 145 feet; beam, 23 feet; depth, 6 feet; and draught with 30 tons on board, 26 inches; displacement, 123 tons. In the case of the *Argus*, the work of putting together the hull and superstructure, mounting battery, and fitting machinery and auxiliaries was completed, and the vessel overboard ready for steam, in ten days from the time of delivery of the material. She had her speed trial on the day following, and a mean speed of 13 knots was maintained during six runs over the measured mile. These vessels are sisters to the *Woodcock* and *Woodlark* of the English navy.

The armament consists of two 3.5-in. R. F. guns, and four 1-pdr. R. F. guns.

The engines are compound, of an aggregate power of 550 i. h. p., and drive twin screws. There are two Thornycroft water-tube boilers.

The speed obtained on so light a draught of water is the most notable characteristic of the boats. In the case of these two vessels it is made possible by the use of the Thornycroft screw-turbine propeller, an ingenious device which, by means of specially arranged guide blades, causes the screw race to be projected more directly astern. For this reason a propeller much smaller in diameter than that which would be needed were the ordinary screw used can be adopted for any given rate of steaming. The designers of the vessels have, however, gone beyond this, and so arranged that part of the propeller is actually above the normal water line. It need hardly be said that a screw not fully immersed is a most inefficient propeller, and in order to get the screws of these boats wholly in the water they are placed beneath the after part of the vessel, the bottom plating being arched up for the purpose. The propeller therefore revolves beneath and partly within the hollow of a kind of elongated flat dome, which may be roughly compared to the inverted bowl of an enormous tablespoon. The edges of the dome naturally dip beneath the water surface, but the crown is well above it. When the propellers begin to revolve water is driven astern, and at the same time it rises within the dome, or tunnel, as it is called, thus driving the air out. The tunnel once filled with water is kept full by the pressure of the atmosphere on the surface of the surrounding water. This is in accordance with well-known natural laws which prevent the formation of a vacuum in the tunnel such as would be caused by the subsidence of the water therein.

Their battery decks are surrounded for a depth of 3 feet by special bullet-proof steel plates $\frac{3}{16}$ inch thick. The deck houses are covered by the same description of armor, which is loopholed for rifle fire. The whole of the engine and boiler spaces are also protected by bullet-proof steel plates. Cabin accommodation is provided for the commander, 2 officers, and 8 engineers and petty officers. The total complement of officers and crew is 30. The men are berthed on the upper deck, hammocks being slung under the fixed awning which surmounts the whole. This will afford accommodation in warm weather, but a new departure in these shallow-bodied, light-draught boats is introduced in utilizing the hull proper for cabin purposes for the men. As the quarters will be somewhat cramped below deck owing to small head room, this accommodation is doubtless for cold weather. A great deal of difficulty is experienced in steering these flat-bottomed, shallow-draught boats. As every inch of draught must be utilized, no vertical keel or deadwood is possible, and in order to prevent the boats from making excessive leeway there have been fitted a couple of lee-boards similar to those used in ordinary Thames sailing barges. These, when lowered, will naturally add considerably to the water the vessel will draw, but doubtless the 2 foot maximum is an emergency draught, necessary only for passing occasional shallow places. The lee-boards will, of course, be also useful to prevent the vessel from blowing off before the wind when the engines are stopped. They are placed well forward, at about the distance from the bow at which the boat would pivot when the turning movement was well established, and this will add very much to the maneuvering properties of the vessels. The hull is built in eleven separate floatable sections, so that it can be divided up for the purpose of transportation. There is a conning tower forward, in which there is a wheel, there being another steering station in the upper deck house. Both hand and steam steering gear is provided. There is a search-light forward, and two boats are carried.

AUDACIEUX TYPE.

There are six torpedo boats of this type building for the French navy, of which the names and dates of launch follow:

Name.	Built at—	Date of launch.
Audacieux	Nantes	Aug. 29, 1900
Mistral	Havre	May 4, 1901
Simoun	Graville	Mar. 23, 1901
Sirocco	Havre	Feb. 20, 1901
Trombe	Nantes	July 28, 1900
Typhon	Havre	June 15, 1901

Their dimensions are: length, 148 feet; beam, 16 feet; depth, 10 feet; draught, 8 feet; displacement, 180 tons.

These vessels are interesting, as they are armored abreast the engines and boilers. These compartments are protected by nickel-steel plates 1 inch thick on the sides and on the bulkheads forward of and abaft them. The deck overhead is covered with plates 0.35 inch thick. The domes over the engines and boilers, and those which contain the steering arrangements placed above the deck, are covered with 1 inch plates in the vertical parts and 0.35 inch on the horizontal surfaces.

The armament consists of two 3-pdr. R. F. guns and three torpedo tubes. There is one 16 inch search-light on each boat.

The engines are of the usual type and are to develop 4,350 i. h. p. and give a speed of 26 knots. The maximum coal capacity is 25 tons, giving a steaming radius of 250 miles at full speed and of 2,500 miles at 10 knots speed.

GERMANY.

WITTELSBACH CLASS.

This class of first-class battleships, a new type which is to be an improvement on the *Kaiser* class, includes the following vessels, all of 11,800 tons:

Name.	Built at—	Laid down.	Launched.
Wettin	Danzig	Oct. 10, 1899	June 6, 1901
Wittelsbach	Wilhelmshaven	Sept. 30, 1899	July 3, 1900
Zaehringen	Kiel	Nov. 21, 1899	June 12, 1901
"F"	Stettin	May 15, 1900	
"G"	Wilhelmshaven	Oct. 18, 1900	

The first three were formerly known as "D," "C," and "E," respectively. They have 800 tons greater displacement and 1,000 i. h. p. more than the *Kaiser* class and there is some difference in their armor and armament.

Their dimensions are: length, 418 feet; beam, 68 feet; draught, 25 feet; displacement, 11,832 tons.

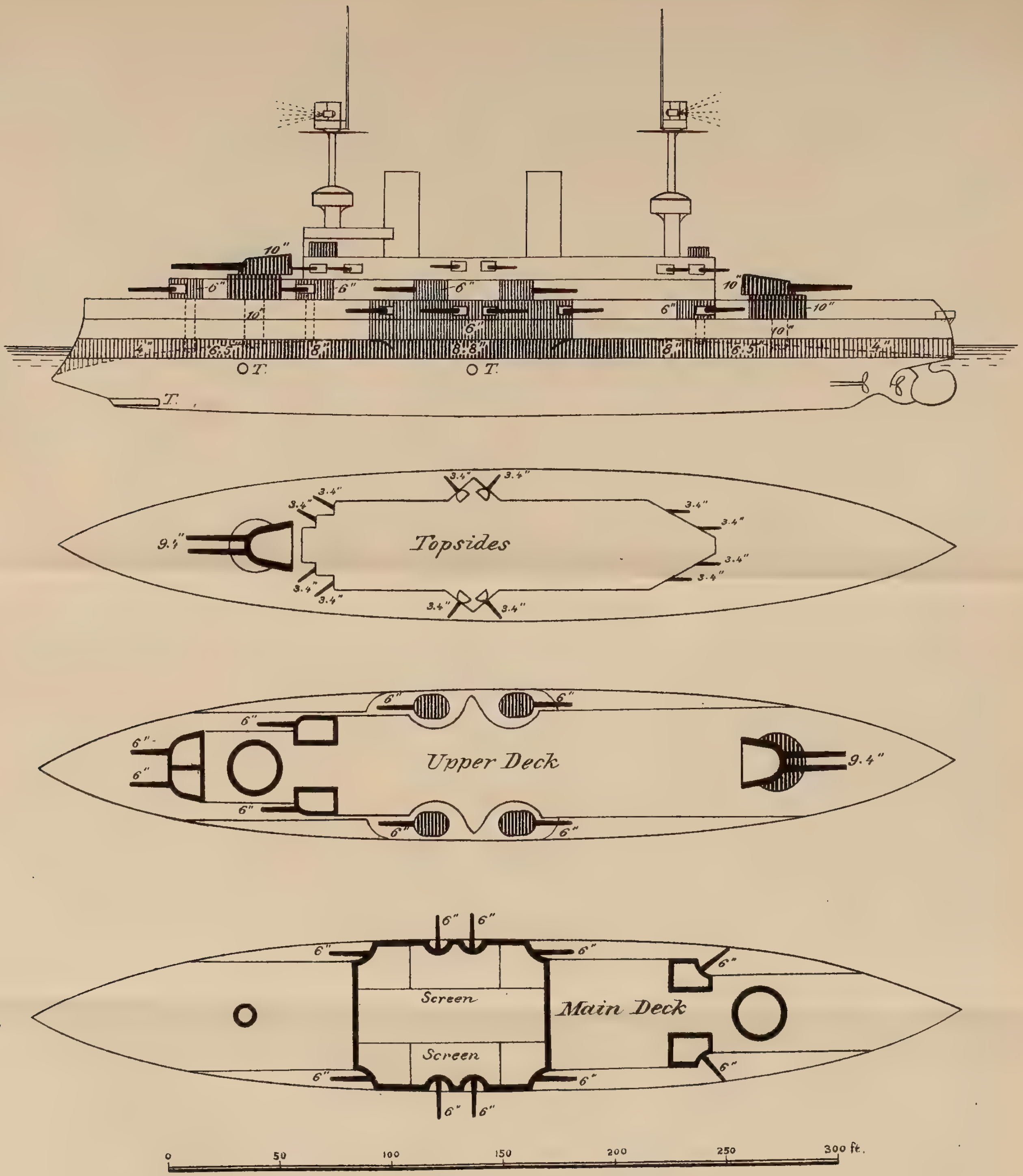
They are built of steel, with a superstructure on the middle part of the ships, and have two military masts and two smoke-pipes in a fore-and-aft line. The launching weight of the *Wittelsbach* was 5,480 tons. The stem weighs 34 tons and the sternpost 30 tons.

The armor is all on the Krupp system. The armor belt is an all around belt 8.8 inches thick at the upper edge amidships, tapering to 4 inches in thickness forward and aft. The thickness at the lower edge is 4 inches throughout. There is a protective deck 1.5 inches thick on the flat and 3 inches thick on the slopes. There is a citadel on the main deck carrying eight 6-in. guns and protected by 6 inches of armor. The turrets and barbettes forward and aft are 10 inches thick, the guns in the forward one being 30 feet above the water-line, those aft being 21.5 feet above it. All the gun emplacements outside the citadel have armored ammunition tubes of the same thickness as the armor protecting the guns. The forward conning tower is of 10 inch steel, the after one of 6 inch steel. The total weight of armor is 2,800 tons.

The armament consists of four 9.4-in. guns in hooded barbette turrets forward and aft; eighteen 6-in. R. F. guns disposed as follows: Eight in the main deck citadel battery, protected by 6 inch armor, and having two fore-and-aft splinter screens and two athwartship screens on either side to isolate the guns; four in separate turrets 6 inches thick above the citadel; two in casemates at the after corners of the gun-deck superstructures; two similarly placed at the forward corners of the spardeck superstructure, and two in armored redoubt forward of the bow turret, all protected by 6 inch armor; twelve 3.5-in. R. F. guns in the spardeck superstructure; twelve 1-pdr. R. F. guns and eight machine guns. They have six torpedo tubes, of which five are submerged, one in bow, two on each broadside, and one above water aft. In the *Wittelsbach* the after one is also a submerged tube, though it is reported from a different source that it will be above water and protected by armor.

There will be three vertical triple-expansion engines installed in separate water-tight compartments, actuating separate three-bladed bronze screws. There will be a large number, about 100, auxiliary engines, but the greater part will be electrically driven.

Steam will be supplied by twelve boilers, six cylindrical and six on the Schultz system. The cylindrical boilers are to be used exclusively for cruising service and the others only when making maximum speed.



WITTELSBACH, GERMAN BATTLESHIP, 11,832 TONS.

The cylindrical boilers weigh 30 tons each, have a grate surface of 517 square feet, and a heating surface of 17,440 square feet, the working pressure being 210 pounds.

The Schultz boilers have a grate surface of 491 square feet, and a heating surface of 24,760 square feet.

The engine and boiler-rooms are separated by a water-tight bulkhead extending to the upper deck.

In the construction of the *Wittelsbach* class wood is being used again for the first time, after having been carefully avoided for several years. Recent experiments have shown that the danger of fire on board modern ships is not nearly so great as it was deemed to be after the Spanish-American war. The decks are covered with 2.4 inch teak.

The normal coal supply will be 650 tons, maximum 1,250 tons, and there is provision for 200 tons of liquid fuel. The engines will be of 14,000 i. h. p., with a maximum speed of 18 knots.

The complement will be 69 officers and 651 men when used as flagships.

The cost will be $5,440,747, of which $4,051,361.25 is for the ship, $1,216,625 for armament, and $172,760.75 for torpedoes.

PRINZ ADALBERT.

This armored cruiser, laid down at Kiel July 5, 1900, and launched June 22, 1901, designated until her launch "armored cruiser B," has been reported as being a sister ship to the *Prinz Heinrich*, described in General Information Series No. XVIII, page 65, but she will carry a different armament, consisting of four 8.27-in. (21-centimeter) R. F. Krupp guns, ten 5.9-in. R. F. guns, and twelve 3.46-in. R. F. guns, besides smaller guns, while the type ship carries two 9.4-in. guns, ten 5.9-in. R. F. guns, and ten 3.46-in. R. F. guns, besides smaller guns, the statement that she had four 9.4-in. guns in the description being an error.

She also differs from the *Prinz Heinrich* in the following particulars: Her displacement is 9,048 tons, i. h. p., 16,200, and speed, 22 knots.

FREYA AND VICTORIA LUISE.

These ships have had a pair of 3.4-in. R. F. guns mounted under forecastle right forward. They are described in General Information Series Nos. XIV and XV.

GAZELLE CLASS.

In this class of small cruisers of 2,660 tons, the following vessels are included:

Name.	Built at—	Laid down.	Launched.
Amazone	Kiel	Dec. 1, 1899	Oct. 6, 1900
Ariadne	Bremen	Dec. 14, 1899	Aug. 10, 1900
Gazelle	Kiel	Apr. 14, 1897	Mar. 31, 1898
Medusa	Bremen	June 22, 1900	Dec. 5, 1900
Niobe	do	Aug. 30, 1898	July 18, 1899
Nymphe	Kiel	Nov. 29, 1898	Nov. 21, 1899
Thetis	Danzig	Sept. 2, 1899	July 3, 1900

Their dimensions are: length, 328 feet; beam, 38 feet 8 inches; draught, 15 feet 9 inches; displacement, 2,660 tons. They are built of steel with very pronounced ram bow, raised poop and forecastle, two signal masts and two smoke-pipes in the fore-and-aft line, two bridges, one forward of the smoke-pipes and one between the pipes about the conning tower, which is of 3.15 inch steel. This was the arrangement in the *Gazelle.* In the others the bridge and conning tower are forward of the smoke pipes, and the *Gazelle* has been altered to the same arrangement. There are raised screens, forming a sort of a redoubt on poop and forecastle, within which the guns are mounted. The *Gazelle* and *Niobe* are the only ones of the class sheathed and coppered. For the protection of the engines, boilers, steering mechanism, ammunition rooms, etc., a protective deck extends over the whole ship at about the water line, sloping off obliquely toward both sides. This deck is 0.8 inch thick on the flat and 1 inch thick on the slopes, being 2 inches thick abreast the engines and boilers. All hatches on this deck have coamings 3.5 inches thick. Upon this deck along the side is a cofferdam filled with a substance which automatically closes shot holes so as to prevent the entrance of water. The coal bunkers lying amidships above the protective decks will form, when filled, a further protection of the vital parts. The employment of wood has been almost entirely avoided, and is used only for such parts as can be readily removed from on board.

The ships carry 8 boats, among them a steam launch.

The armament consists of ten 4-in. R. F. guns, two each on poop and forecastle and three on each side of main deck in sponsons, all protected by shields 2 inches thick; ten 1-pdr. R. F. guns, and eight machine guns of 8 millimeters caliber. They have two submerged torpedo tubes for 18-in. torpedoes.

The engines consist of two four-cylinder triple-expansion engines, each driving bronze 3-bladed screws, and together develop about 8,000 i. h. p., and give to the ships speeds of 21 to 22 knots.

Steam is supplied by eight water-tube boilers, in two separate water-tight compartments, which work with forced draft and at a pressure of 225 pounds.

Coal capacity, maximum, 580 tons.

Complement, 259, officers and men.

PANTHER.

This gunboat is of the same type as the *Luchs*, recently finished, but differs from that vessel in having slightly greater beam and less draught, giving her a slightly increased displacement.

She was laid down in the imperial yard at Danzig July 16, 1900, and launched April 1, 1901.

Her dimensions are: length, 203 feet 5 inches; beam, 32 feet; draught, 10 feet 2 inches; displacement, 977 tons.

She is without armor and has no torpedo armament. The armament consists of two 4-in. R. F. guns, six 1-pdr. R. F. guns, and two 8-millimeter machine guns.

Her engines are of the vertical triple-expansion type, driving twin screws, and should develop 1,300 i. h. p. and give a speed of 13.5 knots. Her maximum coal supply is 240 tons, giving her a steaming radius of 3,000 miles at 10 knots speed.

The complement will be 127 men.

High Sea Torpedo Boats.

The division of high sea torpedo boats (torpedo-boat destroyers) to be known as S-96 to S-101, has been completed during the year.

They are of the following dimensions: length, 221 feet; beam, 21 feet 6 inches; draught, 10 feet; displacement, 350 tons; i. h. p., 5,400; speed, 26 knots.

They will carry five 50-millimeter guns and three torpedo tubes. It is reported that one of these is to be a submerged tube.

HOLLAND.

ASSAHAN.

This new gunboat of the type of the *Siboga* was completed in 1900, and it is now in service in the Dutch East Indies.

Her dimensions are: length over all, 176 feet 2 inches; between perpendiculars, 166 feet; beam, 31 feet; mean draught, 10 feet 3 inches; displacement, 810 tons.

She has no armor protection.

Her armament consists of two 4.1-in. 35-cal. guns, one forward and one aft, each about 17 feet above the water-line; four 1-pdr. R. F. guns, carried on platforms on the main deck, which raise them just above the rail, two abreast the smoke-pipe and two under the middle of the boats just forward of the mainmast; two 37-millimeter revolving cannon on the ends of the bridge; one 12-pdr. for landing service, and one 12-pdr. mortar.

She carries no sail, has two pole masts, and one smoke pipe.

There are two vertical triple-expansion three-cylinder engines, diameters of cylinders 13.5, 20, and 30 inches, with stroke of 18 inches. Steam pressure, 180 pounds; i. h. p., 1,000; speed, 13 knots; propellers, four bladed, bronze, diameter 7 feet 3 inches; pitch, 7 feet 10 inches. She has three boilers, two main and one auxiliary. They are cylindrical, the main boilers 10 feet in diameter and 12 feet long, the auxiliary 6.5 feet in diameter and 8.5 feet long. Forced draft is provided for on Howden's system.

HYDRA AND SCYLLA.

These two torpedo boats were finished in 1900, having been built by Yarrow & Co., in England, and are for use in the Dutch East Indian colonies.

They are 130 feet long and 13 feet 6 inches beam, and have a displacement of about 90 tons. Their guaranteed speed on official trial, carrying 16½ tons, for three hours, was 23 knots.

The general arrangement of these boats is similar to what is customary in vessels of this class, the screw space being forward and the officers and petty officers having their cabins aft. The machinery consists of a set of inverted triple-expansion surface-condensing engines, indicating about 1,200 horsepower. The air and feed pumps are driven off the forward end of the crank shaft.

The special features about these engines, in which they differ from those of other torpedo boats, is the system of forced lubrication which has been adopted, the working part of the engines being completely enclosed. This plan has been introduced with great success in many types of land engines. It consists in enclosing the engines completely, making the bottom of the torpedo boat, as it were, the bottom of a tank to contain oil. A small pump is provided for pumping the oil from the bottom of this tank and forcing it through numerous pipes led to the different bearings. There is nothing new in this system of lubrication, which has been adopted somewhat extensively for stationary engines, but this is, it is believed, the first time that it has been fitted on board a ship. It has the advantage of giving a very large supply of oil to all the bearings, as, of course, with this system the oil is recovered and used over and over again, while with the ordinary system one is limited in a great measure in the supply of oil, as what is used is mostly lost. Therefore, this arrangement enables an overwhelming quantity of oil to be supplied, which is undoubtedly a good thing, combined, as it is, with no waste or no appreciable waste. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this point, which is one of the most important in the proper working of fast-running machinery. As a consequence, a small engine-room staff may, in case of emergency, control the machinery, as the lubrication, being self-acting, does not require attention. This might be a circumstance of the very first importance in time of war, when engineers and artificers may be very scarce indeed.

There is a centrifugal circulating-pump with its engine, for supplying the condenser with water; an evaporator and distilling plant, in duplicate; steam steering-engine and air-compressor; also dynamo for electric lighting. There is an overhead fan and fan engine in the fire-room, between the two boilers, for forced draft.

The boilers are of the Yarrow, water-tube type, with, of course, straight tubes.

There is a Worthington pump engine in the fire-room for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-in. swivel torpedo tubes, and two 6-pdr. R. F. guns.

Both of these vessels, after their regular official trial, have had full speed trials, to show their capabilities when burning astatki, by means of Holden's spraying apparatus, with which the vessels are fitted. It has been shown by these trials that there is no difficulty in burning this oil, and, as it is plentiful in the Dutch East Indies, there is no doubt it will be found an important adjunct to coal. It is proposed to burn the two in combination.

OPHIR CLASS.

Three first-class torpedo boats of this class have been built by Yarrow & Co., at Poplar. They are of the Austrian *Boa* type, and have been named *Ophir*, *Pangrango*, and *Rindjani*.

The first was launched March 6, 1901, the second April 17, 1901, and the third July 2, 1901. The first two have had successful steam trials, which will be noted under that head.

Their dimensions are: length, 152 feet 6 inches; beam, 15 feet 3 inches; draught, 7 feet 4 inches; displacement, 115 tons; i. h. p., 1,900; speed, 26 knots.

The armament will comprise two 50-millimeter R. F. guns and three torpedo launching tubes.

These boats have twin screws and steam is supplied by two boilers of equal size. Arrangements are made so that either coal or oil may be used for firing, the oil burners being on Holden's system.

ITALY.

REGINA ELENA AND VITTORIO EMANUELE.

These new battleships represent a novel, or practically novel, type, there being no ship that they can be described as evolutions from. The first is to be built at Spezia and the second at Castellammare.

The dimensions have been reported as differing, but later reports say they will be identical in every respect. There is a report that the first will carry three 12-in. guns, but this can not be verified.

Their dimensions are: length, between perpendiculars, 435 feet; length over all, 475 feet; beam, 75 feet; mean draught, 25 feet 10 inches; displacement, 12,625 tons.

Protection will be given by an all-around belt at the water-line, 10 inches thick amidships, and 4 inches thick at the extremities. The protective deck will be 4 inches thick, splinter deck 2 inches thick. Bulkheads and barbettes will be 8 inches thick; barbette hoods, side above the main belt from forward turret to abreast main mast and the 8-in. turrets, 6 inches thick; and the conning tower 10 inches thick. All the armor will be Terni make.

The armament will consist of two 12-in. guns in turrets forward and aft, twelve 8-in. R. F. guns in six turrets, three on each side, the amidships turrets being one deck above the others; twelve 12-pdr. R. F. guns; two 12-pdr. boat and field guns, and twelve 3-pdrs. There will be four submerged torpedo tubes.

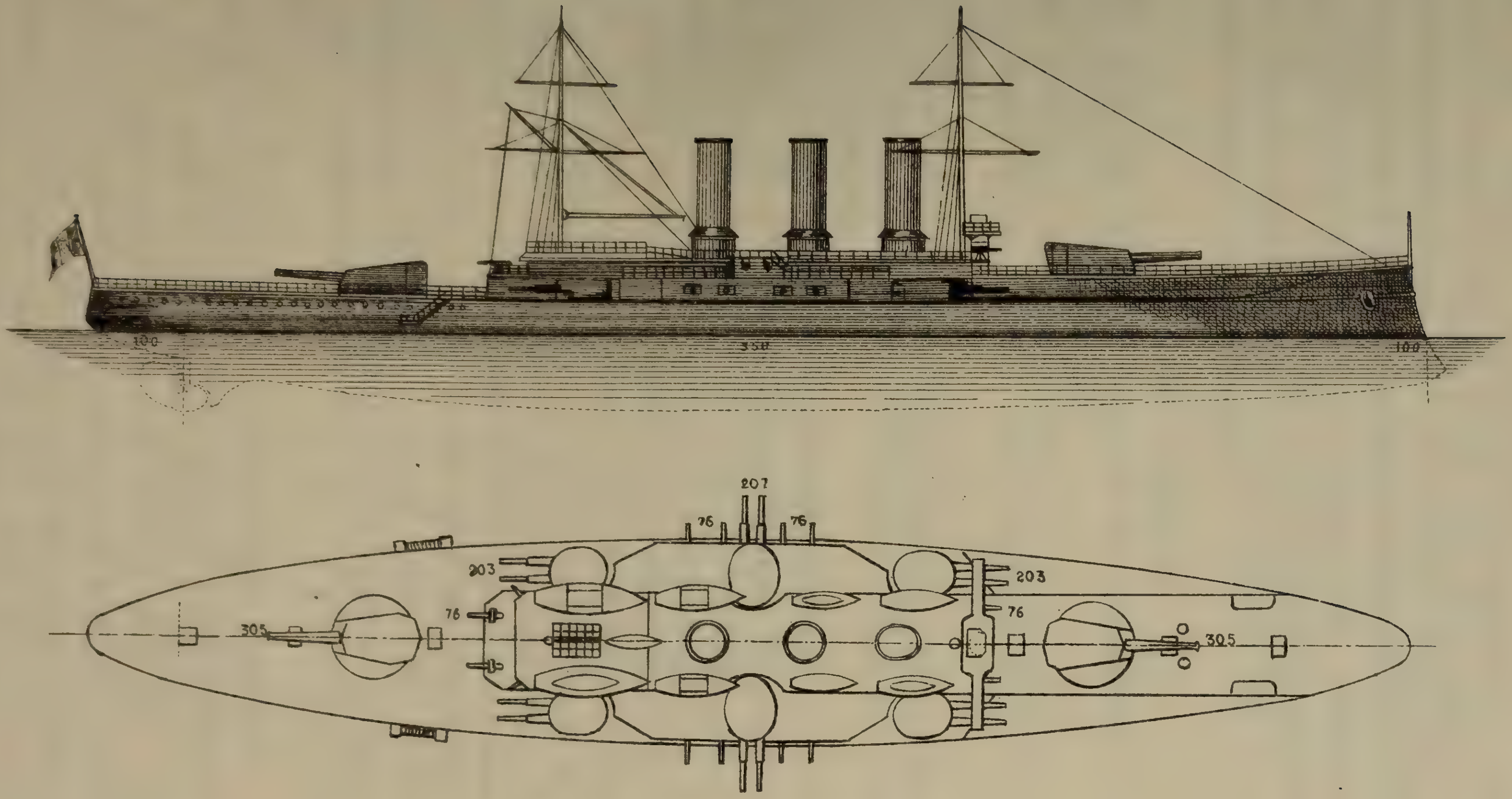
They will be supplied with triple-expansion engines, driving twin screws. The estimated power is 19,000 i. h. p., giving a speed of 21 to 22 knots. The type of boilers has not yet been decided upon.

The normal coal supply is 1,000 tons, maximum capacity 2,000, which will give a radius of action of 10,000 miles at a speed of 10 knots.

The tank trials of the model have given a speed of 23 knots.

The ships are to have two signal masts and three smoke-pipes in a fore-and-aft line, the abolition of the military mast being noticeable. The principal point about the armament is the omission of the 6-in. gun and adoption of the 8-in. R. F. guns, which, however, is more in line with our practice than with that of foreign navies.

A feature of these ships is their relatively low freeboard, though they are higher forward than other Italian battleships, which, built as they are to operate in peaceful waters, do not need much freeboard. The raised bow is advantageous for high speeds, and the ships are certainly flyers, the more so as the model implies a speed of 23 knots; that is to say, these battleships will equal the swiftest armored cruiser building. They are weak in heavy guns, but the four upper deck 8-in. represent an equivalent weight and are presumably chosen in preference to a couple more 12-in. guns. Altogether the ships represent something new in naval architecture. Italy gave us the "protected



VITTORIO EMANUELE, ITALIAN BATTLESHIP, 12,625 TONS.

cruiser" in the *Italia* and *Lepanto;* she has now given the world a new idea for battleships. It remains to be seen whether other nations will follow suit. If they do, if 22-knot battleships are to be the order of the day, all armored cruisers, as we have them—built or building—will have lost their *raison d'être*, for this new Italian design is a bold attempt to do away with compromise and specialization by putting all the qualities most needed for war into one ship. Whether the idea is sound can not be said, but there is a balance of probability in its favor. In any case, if these ships are a success, they will profoundly affect the future of war-ship designs.

REGINA MARGHERITA.

This first-class battleship was laid down at Spezia November 20, 1898, and launched May 30, 1901.

Her dimensions are: length between perpendiculars, 426 feet 6 inches; beam, 78 feet 2 inches; mean draught, 27 feet; displacement, 13,426 tons.

The vessel has a ram bow, raised forecastle, two masts with military tops and signal yards, three smoke-pipes, bridge and conning tower forward of foremast.

The protection consists of a complete water-line belt 6 inches thick in the wake of the redoubt, a distance of about 263 feet, decreasing in thickness toward the ends of the ship. Above this belt the sides are protected by 6 inch armor along the whole length of the redoubt. The barbettes for the 12-in. guns are 8 inches thick, and the turrets for the 8-in. guns 6 inches thick. The protective deck is 1.6 inches thick in the amidships portion, and 3.15 inches thick on the slopes. As a special protection against torpedoes a stratum of coal is to be placed below the protective deck inside the hull, the Italian naval constructors considering coal one of the most effective means of protection against severe shocks. The central part of the vessel under the whole length of the redoubt has a double bottom, and there are many water-tight compartments formed by transverse and longitudinal bulkheads.

The armament has been the subject of many alterations. The latest reports give the following as the number and distribution of the guns: Four 12-in. guns in two hooded barbettes, forward and aft; four 8-in. R. F. guns singly in turrets, two on each side; twelve 6-in. R. F. guns in broadside, six on a side, in an armored redoubt; sixteen 12-pdr. R. F. guns; eight 3-pdr. R. F. guns on the bridge and superstructure; two 12-pdr. boat and field guns, and four mitrailleuses. There are four torpedo tubes, of which three are submerged.

The motive power is supplied by two four-cylinder triple-expansion engines capable of developing 19,000 i. h. p. with forced draft, which should give a speed of 20 knots per hour. Under natural draft, with 16,000 i. h. p., the speed is expected to be 19 knots.

Steam is supplied by twenty-eight water-tube boilers of the Niclausse type placed forward of the engines in three large compartments. There are three smoke-pipes, two abreast and the third abaft this pair. The guns, ammunition hoists, and many of the auxiliaries are worked by electricity supplied by four dynamos. Eight search-lights are provided. The maximum coal capacity is 2,000 tons, giving a radius of action at 10 knots of 10,000 miles.

The complement will be 36 officers and 655 men.

DARDO—EURO—OSTRO—STRALE.

These torpedo-boat destroyers have been completed at Elbing within the past year.

Their dimensions are: length, 200 feet; beam, 21 feet 7 inches; maximum draught, 8 feet 9 inches; displacement, 320 tons.

The armament consists of one 12-pdr. and five 6-pdr. R. F. guns and two above-water torpedo tubes.

The engines are designed for 6,000 i. h. p. and a speed of 30 knots. The boilers are of the Belleville type.

JAPAN.

ASAHI AND HATSUSE.

These battleships of the *Shikishima* class have been completed and placed in service during the past year. Although similar to the *Shikishima* in general design, they are larger by 350 tons and are improvements on that ship in many respects, and are among the most formidable battleships afloat.

The *Asahi* was built by John Brown & Co., at Glasgow, laid down July 5, 1897, and launched March 13, 1899; while the *Hatsuse* was built by Armstrong, Whitworth & Co., at Newcastle, laid down September 24, 1897, and launched June 27, 1899.

Their dimensions are:

Length between perpendiculars	400 feet.
Length over all	425 feet 6 inches.
Breadth, extreme	75 feet 2½ inches.
Depth molded	43 feet 7½ inches.
Normal mean draught	27 feet 3 inches.
Displacement	15,200 tons.

GENERAL DESCRIPTION.

They are built of steel throughout, and the framing is on the bracket system. The ram, stem, sternposts, and shaft brackets, are malleable steel castings. There are four principal decks, lower, middle or protective, main, and upper; the plans of these and of the boat deck, etc., have been reproduced. Below the protective deck the framing is very uniform, the spacing amidships in the wake of the citadel being

48 inches; above the protective deck in the wake of the citadel, however, the frames are spaced 24 inches apart; forward of and abaft the citadel the spacing is 36 inches. The frames within the limits of the double bottom are 5 by $3\frac{1}{2}$ inches by 12 pounds, and reverse frames with 15 pound brackets, and there are a great number of solid, water-tight floors throughout the ship. Forward of and abaft the double bottom the framing is of the ordinary type, consisting of 6 by $3\frac{1}{2}$ by 3 inches by 15 pound Z-bars split at the bottom, one half forming reverse bar and the other the frame. In the wake of the armor at the forward and after ends the framing is of Z-bars 10 by $3\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{3}{8}$ inches, with a strong longitudinal girder midway between the decks. The longitudinal framing is very thorough, no fewer than five longitudinals being worked between the center keel and the protective deck, and two are water-tight. The depth between the outer and inner bottoms is 42 inches, which gives sufficient room for easy access to all parts of the double bottom. The outer shell plating averages 25 pounds in weight, and the inner bottom plating is of a weight of 15 pounds. The center girder and the middle strake of the inner bottom plating are made specially strong, so as to resist any undue strain when the vessel is docked. There are eleven main water-tight transverse bulkheads, extending from the keel to the upper deck. The bulkhead plating is of a weight of 15 pounds below the water line and $12\frac{1}{2}$ pounds above, well stiffened by vertical and horizontal angle and channel bars. There are 261 water-tight compartments, all of which have been thoroughly tested. Such complete division should prove of great value.

On either side of the ships, under the protective deck, there are arranged ammunition passages for the length of the citadel. The passages are very roomy, and have been designed with the object of having as straight a run through as possible, and to have the fewest obstacles in the way of the service of ammunition to the various guns.

The coal bunkers are arranged both above and below the protective deck, having a capacity in all of about 2,000 tons. They are strongly constructed, and are fitted with all the modern conveniences for the transfer of coal from the bunkers to the fire-rooms. The wing compartments are also adapted for the stowage of coal.

One of the features of the vessels is the omission of wood where it was at all possible. Experiments have been carried out at Clydebank, and it has been found possible to completely fit up a cabin without the use of any wood whatever. All fittings, such as the stands for wash basins, drawers, berths, book racks, etc., are made of sheet steel, and so far as appearance goes there is no difference from a similar cabin fitted with wood. Of course it has been the practice for several years back now to fit all the cabin bulkheads with steel, and such is the case in these vessels. As regards the comparisons in weight or price, there is not much to choose between wood and sheet steel. Then, again, in the matter of wood for decks the same principle has been adopted. All wood on decks that could be done without has been omitted, and corticene laid in its place.

THE ARMOR.

The armored protection is very complete. The plates are of steel treated by the improved Harvey nickel-steel process. The arrangement consists of the now usual forward and after barbettes placed at the ends of the central citadel. The main belt is 250 feet long amidships; the total depth of this belt is 8 feet 2 inches and the lower edge of the belt is 5 feet 6 inches below the normal water line, and the upper edge 2 feet 8 inches above it. The maximum thickness of this belt is 9 inches. The trial plates were subjected to three blows of an energy of 7,208 foot-tons, and stood the test admirably. The central citadel of armor is completed by traverses or bulkheads extending obliquely across the ship and inclosing the bases of the barbettes, which protect the positions of the heavy guns. Forward of and abaft this main belt the protection of the water-line region of the ship is completed by armor carried to the bow and stern.

This armor varies in thickness from 5 to 7 inches. Above the main belt the sides from the top of the main belt to the main deck in the wake of the citadel are covered with armor of a thickness of 6 inches. The traverses or bulkheads are fitted with armored doors for affording convenient means of communication along the deck when in port. The protective or middle deck amidships is sloped so that the edge comes to the bottom of the main belt. Forward and abaft the citadel the protective or lower deck is at a lower level. It will thus be seen that the protection of the vitals of the ships is almost perfect. The protection of the armament is arranged in a very thorough manner. For the 12-in. guns at the extremities circular barbettes rise from the protective deck to a height of 22 feet 4 inches above the normal water line. The maximum thickness of the barbette armor is 14 inches. The guns of the main armament are protected by 6 inch shields, which, of course, revolve with the guns. Each 6-in. gun is enclosed in a casemate with an armored front 6 inches thick and rear plating 2 inches thick. The armor on the main conning tower forward is 14 inches thick, and on the after one 3 inches. The main deck in the wake of the citadel has a thickness of 1 inch, and thus affords additional protection from any shells which find their way in above the main deck.

The main armor and barbettes have been strongly framed and fastened. The belt armor backing is of teak and has a thickness amidships of 4 inches, varying toward the ends of the ships. The backing behind the barbette armor is also 4 inches thick. The armor bolts range from 4¼ to 2 inches in diameter and are tapped into the plates from 5 to 2¼ inches. The bolts are fitted with white hempen grommets saturated with white lead and having well-fitting teak plugs driven over the heads. The armor of the conning tower forward is the only exception to the use of Harveyized nickel-steel; the curvature of the plates, it was found, was too great to enable this class of steel to be successfully employed. The plates in this case are consequently made of ordinary Harveyized steel. The tower armor is 14 inches thick, and the screen plate 12 inches thick. The crown plate is 3 inches of nickel-steel. The tube housing, for voice pipes, etc., is of forged steel, and has a diameter of 2½ feet outside and is 8 inches thick (fig. 3). The ammunition trunks for the 6-in. guns are 2 inches thick, and have cofferdams fitted around them at the protective deck.

THE ARMAMENT.

The armament, which is of Elswick design and manufacture, consists of four 12-in. guns mounted in pairs forward and aft. The axes are at a commanding height above the water, and each pair of guns commands an arc of training of 240 degrees, viz, 120 degrees on each side of the fore-and-aft line of the ship (fig. 4). All the loading and sighting operations are carried out under cover of the thick armored barbettes already described (fig. 3). There are fourteen 6-in. R. F. guns installed on board, eight on the main and six on the upper deck. Four guns can be trained directly ahead and four directly astern, and the total arc of training of each of the 6-in. guns is 120 degrees. Each is enclosed in an armored casemate before mentioned, so designed as to give effective protection to the gun's crew, either from the direct fire of the enemy or from the secondary effects of the explosion of shell in the between decks (figs. 4 and 5). There is quite a host of smaller guns, and they are all placed in what is considered the most effective positions for them, as shown in the plans (figs. 4 and 5). There are twenty 12-pdrs., eight 3-pdrs., four 2½-pdrs., and several Maxim rifles. Four submerged torpedo tubes are carried in two rooms, one at each end of the vessel. The tubes are suited for discharging 18-in. torpedoes, of which 16 are supplied. The vedette boats are fitted with tubes for discharging 14-in. torpedoes.

The following is the supply of ammunition carried for the larger guns of the main and secondary batteries: Forty-five rounds for each of the 12-in. guns, 400 rounds for each of the 6-in. guns, and 600 rounds for each of the 12-pdr. guns. The total weight of ammunition carried is 450 tons.

The stowage of ammunition has been so devised as to lead to the minimum of transport and to the entire avoidance of the crossing of lines of supply to guns of different calibers. This is rightly considered a matter of great importance and will tend to simplicity and certainty in time of action. The magazines and shell rooms for the 12-in. guns are in the hold, and the shell and ammunition can be transferred from them by means of hydraulic hoists, and the gun can be loaded at any position of training. The magazines and shell rooms for the 6-in. guns are arranged on the platform deck, and the ammunition is transferred to the various positions along the ammunition passage. Spacious ammunition lobbies have been arranged for the easy working of the ammunition, and while the ship is in action there is little chance for congestion during the service of ammuntion. Winches are placed in the ammunition passage immediately underneath the 6-in. hoist, and by means of an endless-chain system the ammunition is delivered to the various casemates. The magazines for the smaller guns are in the hold and on the platform decks, whence the ammunition is conveyed by hand to the respective guns. The numerous voice pipes which are fitted form a most important feature in these vessels. By means of these the ships can be directed from a very large number of different positions, and in action this will prove invaluable as a means for fighting the ship. The two masts have military tops, on which are mounted several of the smaller guns. Above the military tops are platforms, on which are placed search-lights. The after masts are fitted with a large derrick for boat hoisting purposes. There are also two yards on each mast for signaling purposes.

THE PROPELLING MACHINERY.

The ships are propelled by two sets of three-cylinder triple-expansion engines. Each of the two sets is designed to develop 8,000 i. h. p., giving a combined indicated power of 16,000.

Each set of engines is placed in a separate engine-room, divided by a longitudinal water-tight bulkhead, which extends the whole length of the machinery space. Each engine room is in all respects similar to but entirely independent of the other.

The main engines are of the vertical inverted type, supported on cast-iron columns at the back, and inclined wrought-steel columns at the front. The soleplates or main bearing frames, which are made of the cast-steel skeleton type to insure lightness, are strongly bolted together so as to form one homogeneous stiff foundation for the engines. All the cylinders are fitted with separate liners, and are steam jacketed. The diameter of the high-pressure cylinders is 32½ inches; that of the intermediate-pressure cylinders, is 52 inches; and that of the low-pressure cylinders, 85 inches; all having a stroke of 4 feet. The high and intermediate-pressure cylinders are fitted with piston valves of the inside type, having approved adjustable packing rings; whilst the low-pressure cylinders are fitted with triple-ported flat slide valves, having a special type of relief frame fitted at the back to relieve them of steam pressure. The weight of all the valves is suitably balanced in order to reduce the strain on the valve gear as far as possible; the latter is of the double-eccentric link-motion type. The cylinders, which are entirely independent castings, are connected by attachments which, while allowing for the expansion of the different parts, insure, at the same time, longitudinal stiffness; and to further increase their stability in the event of ramming, etc., strong struts are fitted between the high-pressure engine and the forward structure of the vessel, as well as transversely between the respective cylinders in each engine room.

The air pumps are not worked by levers in the usual manner from the main engines, but are entirely separate. Close under the main condensers are placed a pair of direct-driven, single-acting air pumps, actuated by steam cylinders working on the compound principle, the pumps running at a speed of 30 strokes per minute. The suction pipes of these air pumps are cross-connected, so that at lower speeds the one set of pumps suffices for both engine rooms, which may prove of great advantage in the event of accidents. The main condensers, which are built of riveted brass plates, are placed in the wings of the ship, and have a collective cooling surface of 16,000 square feet. Adjacent to them, at the after engine-room bulkhead, are placed two auxiliary condensers, one in each engine room, having a combined cooling surface of 2,220 square feet. Water is circulated through the condensers by two 18 inch centrifugal circulating pumps, each driven by independent engines, having, in addition to suctions from the sea, the usual bilge connections.

Steam is supplied by water-tube boilers of the latest Belleville economizer type, working at a pressure of 300 pounds per square inch, which will be reduced at the engines to 250 pounds.

The boilers are placed in three separate compartments, there being in all five fire-rooms running athwartships. The forward and middle groups consist of 10 boilers, placed 5 in a row, back to back; and the aftermost group consists of a single row of 5 boilers. There are thus 25 boilers with economizers, viz, 15 boilers having eight elements and seven pairs of tubes; 10 boilers having seven elements and seven pairs of tubes; 15 economizers having eight elements and ten pairs of tubes; and 10 economizers having seven elements and ten pairs of tubes.

The main feed system consists of three main and three auxiliary pumps of Weirs's double-acting type.

The main steam supply is conveyed by two lines of steel steam pipes, one line being arranged on each side of the ship, and leading into a large steam separator on the after boiler-room bulkhead. Each line of main steam piping is entirely independent of the other, as are also the connecting pipes from the boilers to each of these lines. Any boiler may therefore be cut off from the steam without interfering with the performance of the others in the compartment, as may also any compartment from which these main steam pipes lead, without affecting the working of the other compartment. Any group of boilers may supply steam to any of the engines; and the same remark applies to the feed system.

THE AUXILIARY MACHINERY.

The auxiliary machines are very numerous. They include Brown's steam tiller and telemotor gear, air compressors, engines and dynamos for electric power and lighting, search-lights, workshop engines and machines, ventilating fans, refrigerating machinery, capstan engines and cable gear, combined heating and ventilating apparatus for crews' quarters on the patent thermo-tank principle, coaling winches and Temperley's transporters, boat-hoisting winches.

Steering is effected from different positions of the ships and by alternative methods. The chief and easiest method is by the hydraulic telemotor, which is used in conjunction with the steering engine in the steering compartment aft.

The air-compressing machinery is contained in two rooms on the lower deck. The machinery is used for charging the air chambers in the locomotive torpedoes, the air of course actuating the propelling mechanism of the weapon. The sensible course has been adopted of keeping one end of the ship independent of the other, so that one could be fought after the other has been put out of action. The hydraulic machinery, to which reference should be made, is also in two engine rooms on the lower deck. The power is used for operating the barbette turntables, hoisting ammunition, elevating and loading guns. The rooms are all well ventilated, a point which is not always sufficiently attended to.

The ships are lighted throughout internally by electricity. The engines and dynamos for this purpose are of the most approved design, and the electric lighting arrangements are complete in every respect. The coal bunkers are of course supplied with the fixed lights customary in the most modern of battleships. Two yard-arm reflectors, each with eight 50-candlepower 80-volt incandescent lamps, are also fitted. Six search-light projectors are placed at different positions on each ship, one on each mast and one at each end of the forward and after bridges. These search-light projectors are very powerful and are fitted with automatic carbon feed lamps, those in the tops being also supplied with distant controllers with water-tight Bifranner switch. Electric lighting is arranged also for distant signaling purposes. All such items as compasses, telegraphs, and instruments on the upper deck and bridges, conning towers and torpedo direction towers, the bow and masthead are all fitted with incandescent lights. The dynamos, which are placed in a room on the middle deck, are three in number, of 600 ampères 80 volts. All wire leads are of the best high-conductivity copper, and form a complete wire circuit, no earth being formed by the ship. There is also a complete system of electric bells throughout the ship, with tell-tales fitted in the various important positions.

A workshop for the use of the engineers has been arranged on the middle deck amidships, and is fitted with all the most useful of machines; in fact, it is really a floating repair shop. Nothing has been omitted which would facilitate any repairs being expeditiously carried out.

For ventilation there are six fans driven by steam, arranged three forward and three aft, below the protective deck and within the citadel. These supply fresh air to all the compartments below the water line, and thus all hatches can be closed when in action. All the downcasts to these fans are fitted with armored gratings where they pass through the armored decks. The compartments above the water line are ventilated naturally through cowls. Special ventilation is provided for the coal bunkers, all of which exhaust into the main funnels. There has also been adopted in the crew's quarters of this vessel a patent known as "Stewart's patent ventilating thermo-tank," which combines heating with ventilation, and can be regulated as required. The principle is intended to combine an efficient ventilating system with an improved arrangement of heating. An efficient form of heater is combined with a steam or electrically driven fan, and placed on deck or outside the compartment to be heated or ventilated. This heater is connected to the ventilating trunking through the compartments and rooms, and any required volume of air at any desired temperature can be delivered to the compartment. By a suitable arrangement of valves on the connection to and from thermo-tanks air may be exhausted from the compartment to the atmosphere, or may be circulated in the compartments through the heater, and thereby raise the temperature. It may also be delivered direct into the ventilating trunks without passing through the heater. The temperature can also be reduced when the vessel is in hot climates by means of direct expanded air from a refrigerating plant.

The capstan and cable holders are actuated by a vertical inverted engine having two cylinders, each 16 inches in diameter and 14 inch stroke. The whole of the capstan cable holders are driven from the engine by means of miter gearing. There are two cable holders suitable for the size of the cable carried. They are of cast steel, with solid stops. They are arranged to run loose on their shafts with gun-metal bushes. Each holder is provided with one wrought-steel reliever fitted into a cast-iron rubbing block. A cast-steel drumhead is fitted firmly to the center cable-holder spindle between the forecastle deck and the upper deck to enable the capstan on the upper deck to be worked by hand. There is also a vertical inverted capstan-engine fitted aft, having two cylinders, each 10 inches in diameter and 12 inch stroke, and similar in construction to the forward one. A warping capstan is also fitted on the upper deck aft, and is arranged to work by hand as well as steam. The lower portion is in the form of a cast-steel cable holder suitable for $1\frac{3}{4}$ inch cable. The body of the capstan is portable, and the head is arranged to take a full set of capstan bars.

The anchors and cables are of the best make, and were thoroughly tested before delivery. There are four bower anchors, each of 120 hundredweight, ex-stock; one stream anchor, of 40 hundredweight, ex-stock; three kedge anchors, each of 25 hundredweight, ex-stock. These anchors are all of the latest pattern. They are stowed on bill boards specially constructed and adapted for the speedy transit of the anchor overboard when they are released. There are four cables of $2\frac{9}{16}$ inch stud chain and one cable of $1\frac{3}{4}$ inch stream chain. These are stowed in lockers constructed forward on the lower deck, and are so placed that they are convenient for the cable being easily led to the holders.

They are amply supplied with boats, there being no fewer than 16 of all kinds. These boats are all stowed in such a manner that they can be manipulated in the easiest fashion when required.

OFFICERS' AND MEN'S ACCOMMODATION.

And now to consider the ships from the habitable point of view. The accommodation is of the latest and most approved design, and the size of the various cabins is greater than in other nations' ships of a similar type. Commencing with the main deck aft (fig. 5) there are arranged there the suite of rooms specially designed for the use of the admiral. Here we find a day saloon, dining saloon, bedroom, lobby, and pantry, with bathroom and lavatory, all arranged conveniently to one another. These apartments are all fitted appropriately for their respective uses, and all in first-class style. The paneling of the day and dining saloons is of a light nature, and the furniture is in keeping with it. The bed room, which is fitted with a brass bedstead, is done up in enamel white, and is a large airy apartment. The admiral has also a day cabin arranged on the upper deck in the after deck shelter (fig. 4). This cabin is similar in design to those already described. Adjacent to the admiral's quarters on the main decks, rooms are arranged for the captain, commander, chief staff officer, and six other rooms for officers of the staff. These rooms are fitted with all the latest improvements, and are tastefully upholstered. There are day cabins fitted for captain and chief staff officer, and rooms are set apart as offices for the various secretaries and clerks required. Forward of those cabins, and also on middle deck (fig. 6), are arranged the cabins for lieutenants, engineers, and officers of lower grades. The wardroom is a very large apartment, situated on the middle deck, and is handsomely finished. It is arranged to seat 40 persons, and is fitted up with all the necessary furniture, such as bookcases, settees, tables, etc. The pantry is adjacent to the wardroom with a door for direct communication. The gunroom is also situated on this deck, and is a large apartment, fitted in a neat and substantial manner. Rooms are also arranged on the middle deck aft for charts, chronometers, and compasses, and are fitted up in a manner suitable for their respective uses. Numerous baths for officers and crew are arranged in various parts of the vessel. Ample space has been allotted for the crew, and everything has been provided of the latest pattern, such as bag racks, ditty boxes, hat racks, etc. The messing accommodation is sufficient for 760 men, exclusive of the petty and warrant officers, and, of course, the table and seats can be raised when not in use, so as to give good clearance. The sleeping accommodation for the crew is for about the same number, all to be accommodated in hammocks. The ship's complement, it may be added, consists of admiral, captain, commander, 8 staff officers, 5 lieutenants, 3 surgeons, 3 paymasters, 5 engineers, 5 expert officers, 11 warrant officers, and 730 of a crew, making a grand total of 773 all told.

There are three galleys; admiral's, officers' and crew's, all grouped together on the main deck (fig. 5). The galleys are supplied with the latest type of cooking ranges, boilers, hot plates, and all other items necessary to make a complete galley outfit. The storerooms have been arranged in a very thoughtful manner. The lower deck (fig. 7), forward of and abaft the armored bulkheads, has been entirely utilized for this purpose, the object in view being to keep the stores in such a position that they may be easily got at. All the admiral's, captain's, wardroom, gunroom, and officers' stores are arranged aft, and the boatswain's, warrant officers' and carpenter's stores forward. The bread rooms and provision rooms are large and have ample capacity for long voyages. The fresh-water tanks are built into the ship forward of and abaft the citadel and have a capacity of 17,000 gallons. The wet and dry provision rooms and spirit room are below the protective deck, at the forward and after ends. A refrigerating installation has been fitted on the dense-air principle. The refrigerating chambers are arranged below the protective deck, forward, and are of a very complete nature.

On the upper deck (fig. 4) there are deck shelters, forward and aft, in which are arranged, for the convenience of the officers and crew, the water-closets and seamen's head. Rooms are arranged in the after shelter for use by the admiral and captain as day cabins, as already mentioned. In the forward shelter there are ready-use stores for gunner and carpenter, also lamp room and rooms for other deck stores. Above the upper deck is the boat deck, on which the boats are stowed, and from which the work of manipulating them is performed. There are also several of the smaller guns mounted on this deck.

Navigating bridges are arranged both forward and aft, and they are so arranged that the navigation of the vessels can be carried out with ease. On the forward bridge is the pilot house, immediately above the main conning tower, and on the after bridge is placed the chart room. There is a flying-bridge immediately over the pilot house, forward, from which a clear view can be had of the whole length of the vessel.

MIKASA.

This first-class battleship is, roughly speaking, a sister ship to the *Asahi* and *Hatsuse*, which vessels she follows rather closely in the matters of dimensions, displacement, and armament, but there are important diversions in the distribution of the armor which make her of special interest.

She was built at Barrow by Vickers, Sons & Maxim; laid down January 15, 1899, and launched November 8, 1900.

Her dimensions are: length between perpendiculars, 400 feet; length over all, 432 feet; beam, 76 feet; draught, 27 feet 2 inches; displacement, 15,200 tons.

As in the two earlier Japanese battleships mentioned, the water-line armor belt extends from end to end, instead of terminating at the ends of the citadel and thereby leaving about 80 feet from the stern unprotected.

The main belt has a width of 7 feet 9 inches, of which 5 feet 3 inches is below the water line. The main belt armor in the wake of the citadel for 156 feet in length, is 9 inches in thickness; beyond this at either end—to some distance past the forward and after 12 inch armored transverse bulkheads—it is 7 inches in thickness, assisted by additional 1½ inch nickel-steel plates placed on the slope of the protective deck, so as to make the resistance equivalent to 9 inch Krupp-Harveyized armor, for the whole length of the citadel and barbettes. From the ends of this 7 inch belt to the ends of the ship the armor is 5½ inches and 4 inches in thickness. An athwart-ship bulkhead of 6 inch armor is fitted at the after extremity of the water-line belt to afford protection against raking fire. The Japanese Government, with their characteristic progressive tendency, have introduced in the *Mikasa* a departure which must be of interest to all naval constructors, the effect being to increase the area of the armored broadside. Above the main armor, and extending for the whole length of the citadel, there is 6 inch armor up to the level of the upper deck, instead of to the main-deck as in previous ships, so that the total width is 21 feet 6 inches for the length of the citadel, and 7 feet 9 inches forward of and abaft it.

The two barbettes are 14 inches in thickness, reduced to 10 inches where protected by 6 inch citadel armor, while the guns, as shown on

Fig. 1.

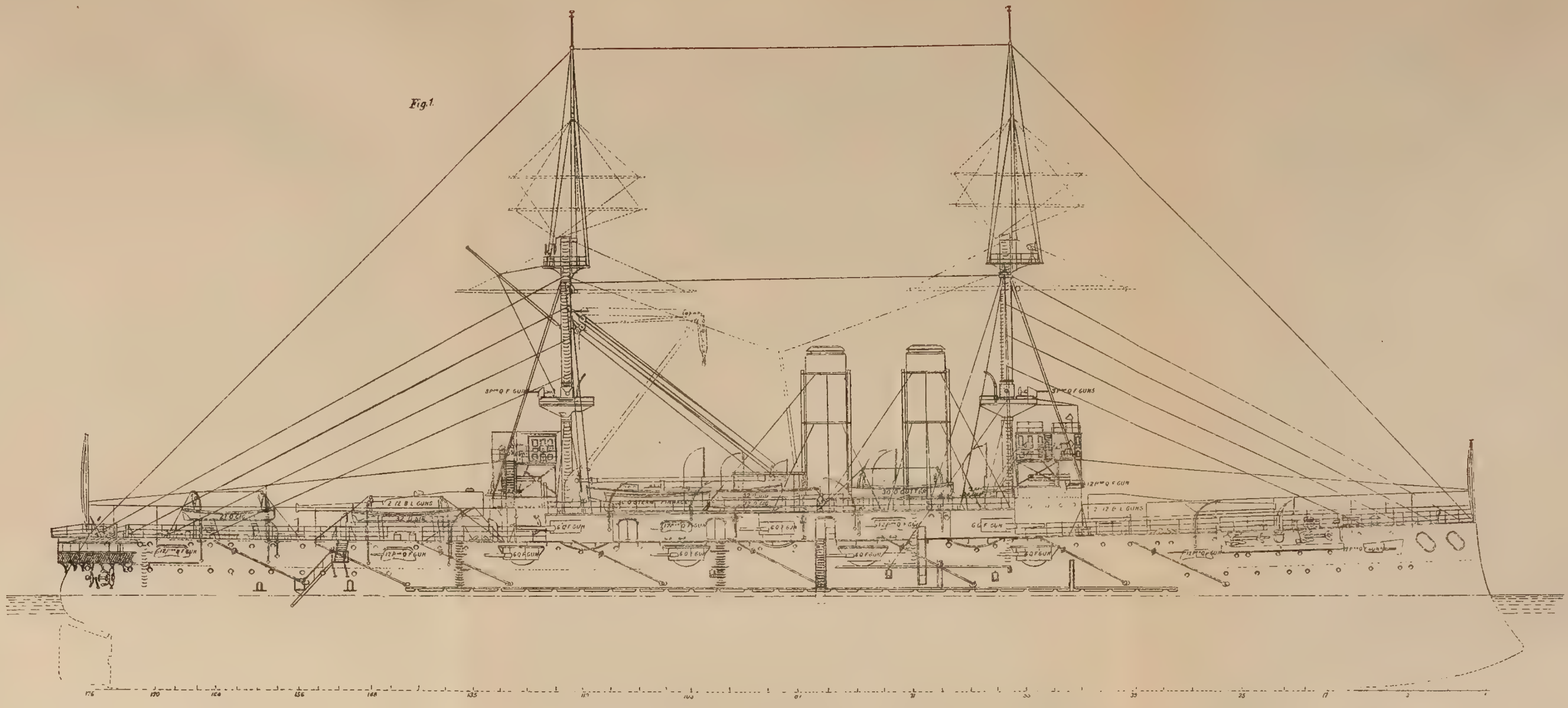
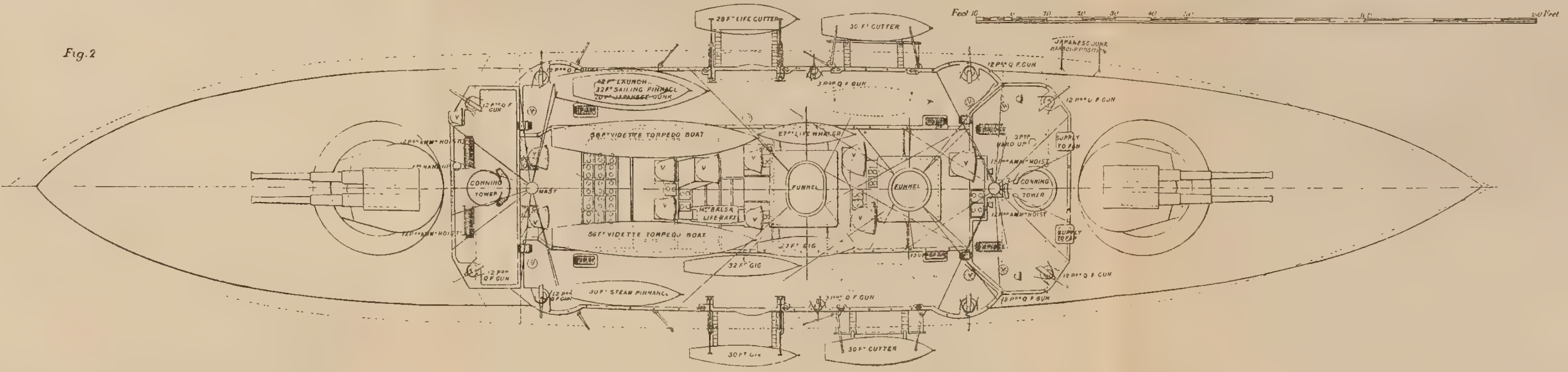


Fig. 2



ASAHI, JAPANESE BATTLESHIP, 15,200 TONS.

Fig. 3.

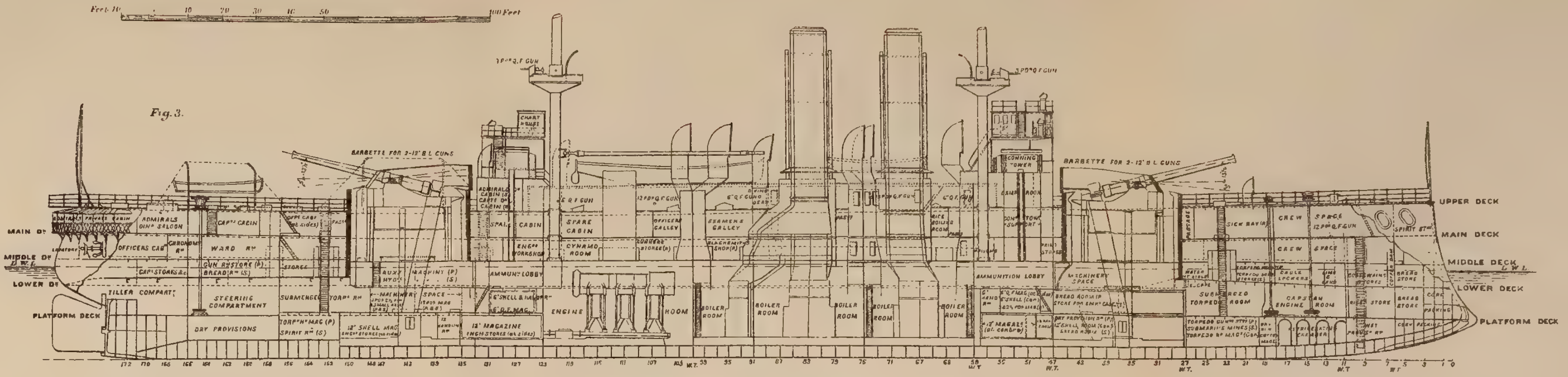


Fig 4 Upper Deck.

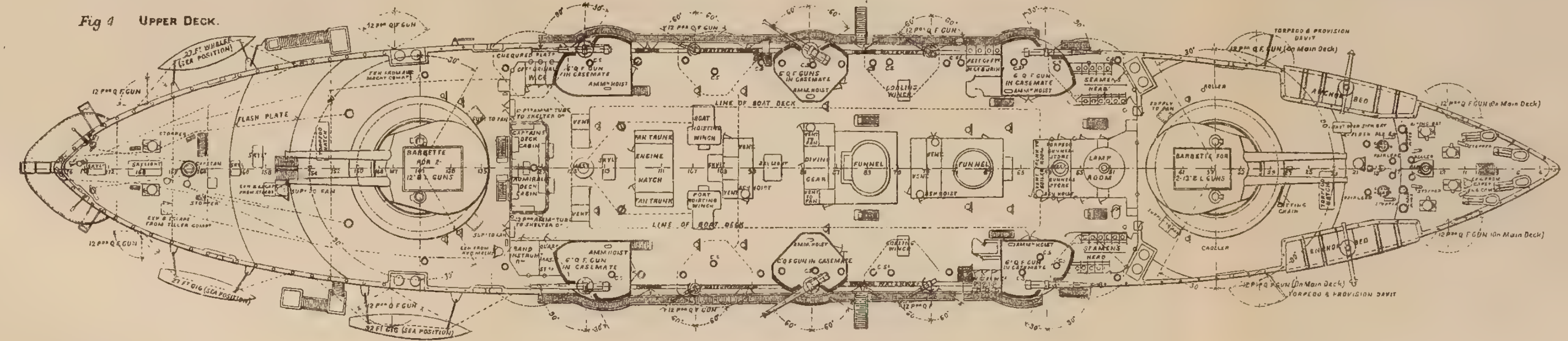
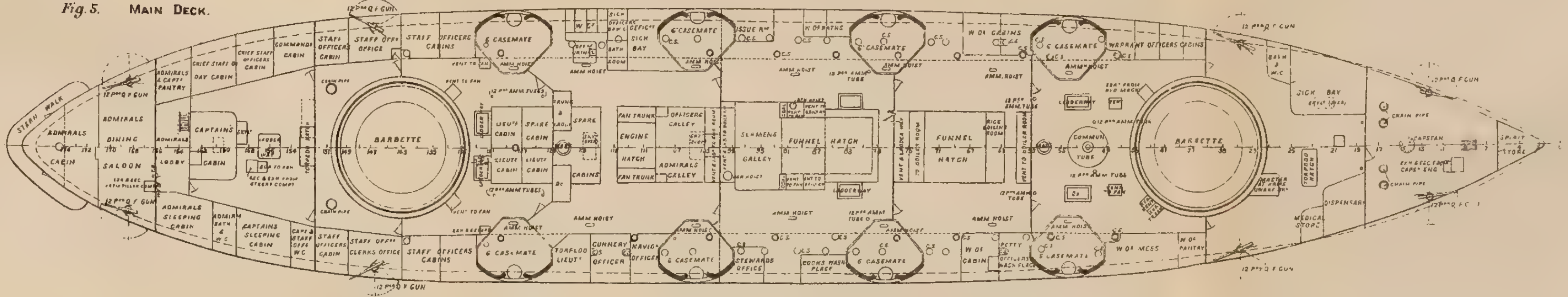


Fig. 5. Main Deck.



ASAHI, JAPANESE BATTLESHIP, 15,200 TONS.

Fig. 6 MIDDLE DECK

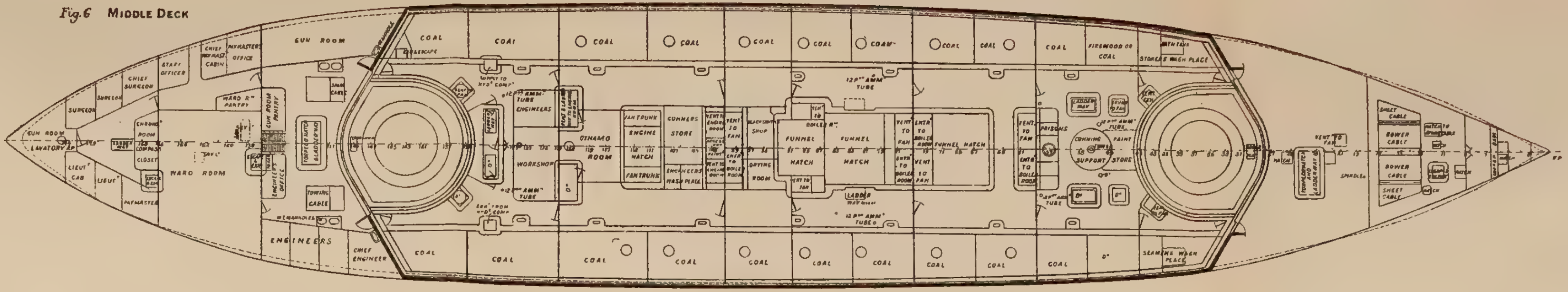


Fig. 7 LOWER DECK

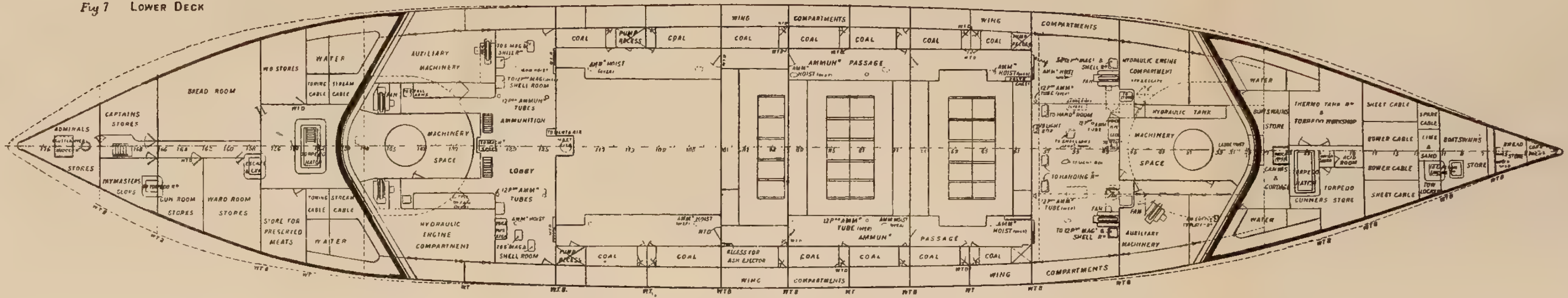


Fig. 8 PLATFORM DECK

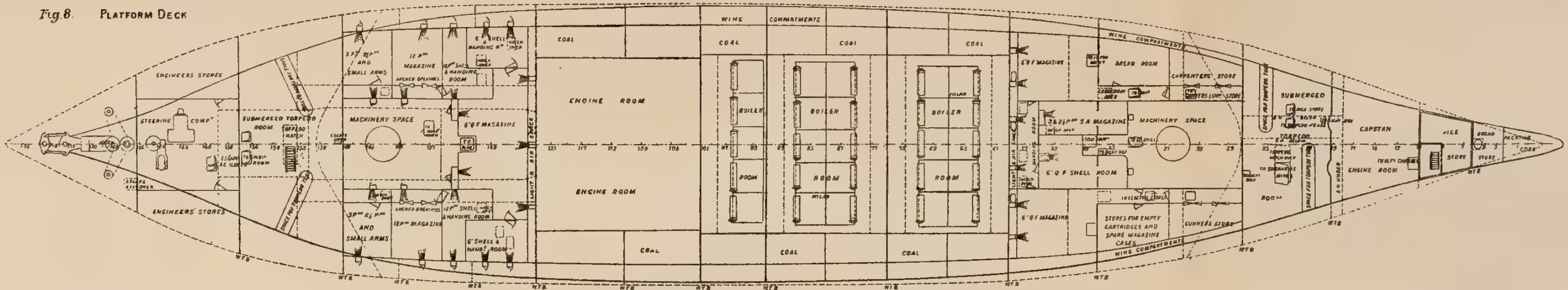
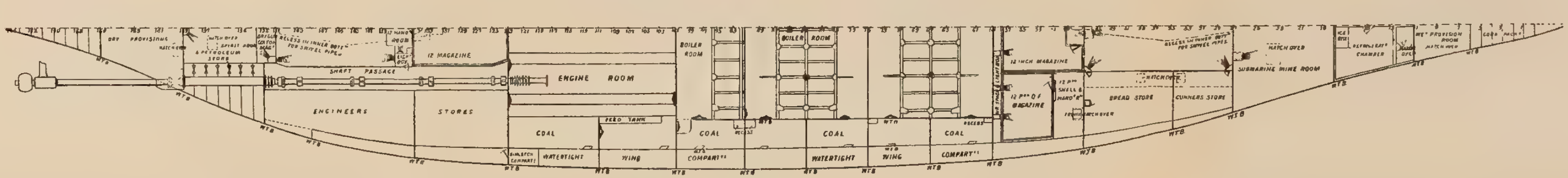


Fig. 9 HOLD PLAN.



ASAHI, JAPANESE BATTLESHIP. 15,200 TONS.

the elevation, are protected by armored shields. The conning tower is of 14 inch armor, the screens being 12 inches, while the observation tower aft is protected by 3 inch armor. The whole of the armor is made on the Krupp principle, and is of a nickel-steel alloy.

The extension of the main belt to the upper instead of to the main deck, as in preceding ships, dispenses with the necessity for casemates for the 6-in. guns on the main deck; but to insure the same measure of isolation for the ten 6-in R. F. guns placed on this deck as is obtained by the casemate system, bulkheads are placed between the guns, while an armored screen extends the whole length of the citadel behind the guns, as shown on the half plan of the main deck. These divisional bulkheads and the armored screen are of hardened steel, sufficient to insure that the splinters of any shell which may explode in one compartment will not affect either the gun or gunners in the adjoining compartment. The 6-in. guns on the upper deck, four in number, are within 6 inch casemates.

The citadel comprises the chief departure from ordinary practice in the design of this ship, as, besides protecting the space between the belt and the main-deck battery, it takes the place of the ordinary arrangement of casemates usually found in foreign battleships, and entirely protects the 6 in. guns on the fighting deck. The advantage of this arrangement over casemates will be seen when it is considered that throughout the whole of the central portion of the ship the crew is protected from injury while working the guns, while the gun positions themselves are quite as well protected in front as in the casemate arrangement, and are much less vulnerable in the rear, where they are now protected by the 6 inch armor on the opposite side of the ship as well as by the thick steel bulkheads which divide the gun positions one from another.

The protective deck is of a minimum thickness of 2 inches, and extends over the full length of the ship, but is increased to 3 inches on the sloping parts within the citadel, and to 4½ inches in thickness in the wake of the barbettes, as before mentioned. In addition to this, the upper deck within the citadel is made of 1 inch plates. As usual, there is an ammunition passage under the protective deck, with communication through ammunition tubes to the various gun positions, while coal bunkers are arranged above and below the protective deck from end to end of the citadel. There is thus an increased broadside protection to the citadel, as well as in the ends of the ship.

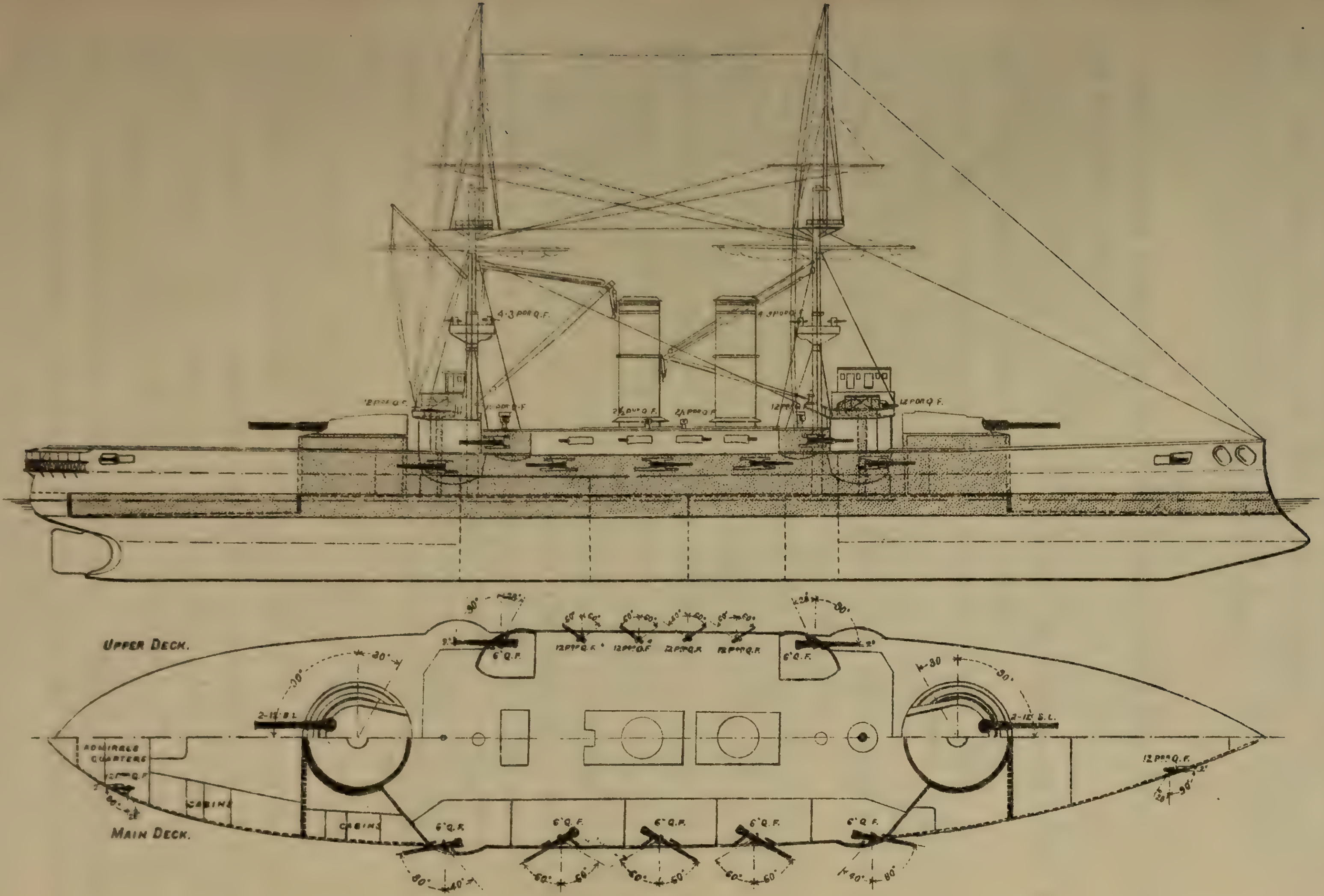
The armament comprises four 10-in. breech-loading guns fitted in pairs in the two barbettes on the upper deck, and fourteen 6-in. R. F. guns, four placed, as already indicated, within casemates situated on the upper deck at the corners of the citadel, the remaining ten 6-in. guns being placed in the box batteries on the main deck. The plans given show the arcs of fire of the respective guns. The auxiliary armament of the ship consists of twenty 12-pdr. R. F. guns, four firing ahead and four astern, the remainder being on the broadsides; eight 3-pdr. R. F. guns; and four 2½-pdr. R. F. guns. There are four submerged torpedo tubes, two in the forward part of the ship and two aft.

The weight of metal discharged by this armament in one minute is 11.5 tons, representing a striking energy of 1,337,130 foot-tons, while the weight of metal discharged from the guns available for one broadside in one minute is 7.5 tons, giving a striking energy of just under 1,000,000 foot-tons.

She is to have a speed of 18 knots under natural draft, and will have a coal capacity of 1,400 tons, to give her a radius of action of 9,000 sea miles at 10 knots speed. The engines are of the triple-expansion three-cylinder type, the diameters of the cylinders being 31 inches, 50 inches, and 82 inches, respectively, the stroke being 48 inches; and it is anticipated that the full power of 15,000 i. h. p. will be developed with the engines running at 120 revolutions per minute, the steam pressure at the engines being 250 pounds, and at the boilers 300 pounds. Stephenson link-motion is adopted for working the valves, which are of the piston type on the high-pressure and intermediate cylinders, and of the double-ported flat design on the low-pressure cylinders. The engines, as with all war ships now, are designed to run the propellers inward when going ahead, so that the starting platform is in the center of the ship; and here, as is now the universal practice, wrought-steel columns form the front supports of the cylinders, which are independent castings. The back supports of the cylinders are of the ordinary cast-iron λ framing, with ample slipper guide surface. The condensers are separate, and placed in the wings of the ship. The total cooling surface is 16,014 square feet.

The bedplate is of cast steel. The working parts of the engine generally are of forged steel, but the crank shaft is of nickel-steel, the three parts being interchangeable. The external diameter is 16¼ inches, with an 8¼ inch hole. The propeller shaft is of wrought steel 16½ inches in diameter, with 8½ inch hole, while the propellers have four blades, the diameter being 17 feet, and the mean pitch 18 feet. The four blades and the boss are of manganese bronze.

The boilers are of the Belleville type, with economizers. There are 25 in all, of which 20 consist of 8 elements of generating tubes and 7 elements of economizer tubes; while the remaining 5 boilers have 7 elements of generating and 6 elements of economizer tubes. The total heating surface is 37,452 square feet, and the grate area 1,276 square feet. The two smoke-pipes are 14 feet in diameter over the casings, the height from the fire grate being 91 feet. There is the usual complete system of pumps, with blowing engines for the furnaces. The total weight of the machinery is 1,355 tons.



MIKASA, JAPANESE BATTLESHIP, 15,200 TONS.

The general appearance of the vessel is indicated by the elevation, and it need only be added that in her electric and compressed-air equipment she embodies the best modern practice, the lighting installation including 900 incandescent lamps, with masthead, bow, anchor, and other special lights, and also 6 search-lights. The ship will be fitted as a flagship, accommodation being provided for an admiral and 78 officers, the complement being 935 all told.

ADZUMA.

This armored cruiser, built at St. Nazaire, was laid down in 1898, and launched June 24, 1899.

Her dimensions are: length, 445 feet 10 inches; beam, 59 feet 6 inches; mean draught, 23 feet 8 inches; displacement, 9,307 tons. When fully loaded the draught aft is 28 feet.

She is built of steel, unsheathed, with ram bow, flush deck, with central superstructure between the masts. Two masts with fighting top and two signal yards on each; three smoke-pipes in a fore-and-aft line, spaced at irregular intervals. There are two bridges and chart rooms just beyond the masts at each end of the ship.

The protection consists of a complete water-line belt 7 inches thick amidships over a length of 207 feet, tapering to 3½ inches thick at the ends. It is 7 feet wide, and extends 5 feet below the water line. All plates above 4.7 inches in thickness are of Harveyized nickel-steel; the thinner plates are of cemented steel. Above this, and covering the space between the masts—a distance of 207 feet—is a partial belt 6 feet wide and 5 inches thick. This belt is of cemented nickel-steel.

The armored deck from end to end of the ship is 2.5 inches thick. The turrets forward and aft are 6 inches thick, and the casemates are of the same thickness of cemented nickel-steel. The turrets are operated by electric, hydraulic, or hand power. Eight men are required to work them by hand. The conning tower is of nickel-steel 14 inches thick.

The armament consists of four 8-in. R. F. guns in two turrets, forward and aft; twelve 6-in. R. F. guns in casemates, four on the main deck in broadside, four on the upper deck in broadside, and four in the corners of the superstructure, all protected by 6 inch armor; twelve 12-pdr. R. F. guns, two in bow and stem, four on top of superstructure, and four in broadside over the main deck 6-in. guns, all protected by shields; eight 3-pdr. R. F. guns; and five torpedo tubes, four submerged and one in the bow. This last is protected by 6 inch vertical armor, extending 21 feet from the stem on each side and 8 feet wide from the top of the main belt.

There are two triple-expansion engines, actuating twin screws, of a collective power of 18,000 i. h. p., and giving a speed of 21 knots, with forced draft, on trial. With natural draft the speed attained was 18.7 knots.

The boilers, of Belleville type, with economizers, are 24 in number, and have given satisfaction. The maximum coal capacity is 1,300 tons, giving a steaming radius at 10 knots of 7,000 miles. There are four electrically controlled search-lights on the ends of the bridges.

The complement is about 666, officers and men.

IDZUMO AND IWATE.

These first-class armored cruisers have been placed in commission within the past year. They were built by Armstrong & Co., at Elswick, and launched September 19, 1899, and March 29, 1900, respectively.

Their dimensions are: length, 400 feet; beam, 68 feet 6 inches; mean draught, 24 feet 3 inches; displacement, 9,900 tons.

They are built of steel, with flush decks, and a superstructure amidships, ram bow, two masts with military tops and signal yards, and three smoke-pipes in a fore-and-aft line. They have two bridges, one forward and one aft, and torpedo-net defense.

The protection consists of a complete belt of 7-inch steel, 7 feet deep along the water-line, the upper edge being 2 feet above the water. This tapers in thickness to 3½ inches at the ends of the vessels, the length of the 7 inch part being 276 feet. Above this belt is another of 5 inches thickness, which reaches beyond the turrets at either end, and is there bent inward and across, forming transverse bulkheads, protecting the turret bases and shielding the vessel from raking fire. The forward bulkhead is 6 inches thick, the after one 2 inches. There is a belt of 6 inch steel extending 25 feet from the stem on either side to protect the bow and support the ram, being about 7 feet wide. A 2 inch ram plate is also fitted to support the ram. The deck above the citadel is 1 inch thick. The conning tower has 14 inch armor, the after observation tower 3 inch armor. The armored communication tube is 6 inches thick. The protective deck is 2.5 inches thick on the flat, and curves down to lower edge of the water-line belt.

The total weight of armor is 2,100 tons.

The armament consists of four 8-in. R. F. guns in two barbette turrets forward and aft; fourteen 6-in. R. F. guns, six on the main deck in casemates, and eight on upper deck, four in casemates and four in 4.5 inch shields; twelve 12-pdr. R. F. guns, and eight 2.5-pdr. R. F. guns. There are four submerged torpedo tubes. The 8-in. turrets are 8 inches thick with 1 inch backing plate, making 9 inches; rear of turrets 6 inches and 1 inch, or 7 inches. The turrets may be worked by electric, hydraulic, or hand power. Eight men are required to work the turrets by hand.

The four 6-in. guns on the upper deck at the corners of the citadel are directly over the forward and after 6-in. guns on the main deck, and there is a good-sized manhole in the deck connecting the two casemates, so as to allow free communication, and to allow one officer to control the two guns and give increased protection to the upper guns by a small addition of armor.

The engines are vertical triple-expansion engines driving twin screws. The i. h. p. developed is 14,000, speed 20.87 knots with natural draft; i. h. p. 18,275, speed 22.2 knots with forced draft. The capacity of the bunkers is 1,300 tons.

They are supplied with 24 Belleville boilers. There are twelve ventilating fans in fire-rooms, two in engine-rooms, all driven by steam, and six electric fans for other compartments. In the after tower is a Barr & Stroud range and battle-order transmitter connecting with each turret and casemate, voice tubes to important stations, engine-room telegraphs, speed indicators, torpedo directors, and electric firing apparatus.

There are four electrically controlled search-lights.

The complement is 483, officers and men.

NIITAKA AND TSUSHIMA.

These second-class protected cruisers have been ordered built at the dockyards at Yokosuka and Kure, respectively, and will probably be laid down about the end of the present year. Materials have been ordered from abroad, but have not yet been received. They will be similar to the *Akitsushima* but will carry somewhat better batteries.

They will be built of steel, with ram bow and full stern, without overhang; will have double bottoms throughout the space between the masts, and will have two signal masts and three smoke-pipes. There will be a bridge forward of the foremast, with a search-light on each end, and a third search-light will be carried on a raised platform on the poop.

The dimensions of the vessels will be: length between perpendiculars, 334 feet 7 inches; beam, 44 feet; mean draught, 16 feet; displacement, 3,365 tons.

There will be a protective deck from stem to stern 1.5 inches thick on the flat and 3 inches thick on the slopes.

The armament will consist of six 6-in. R. F. guns, two in shields on poop and forecastle and four in sponsons on the main deck, on each side abreast the masts; ten 12-pdr. R. F. guns, six in broadside, equally spaced between the 6-in. guns, two on the forecastle under the ends of the bridge and two in the cabin near the stern; four 3-pdr. R. F. guns in broadside on the main deck, two between the forward 6-in. and forward 12-pdrs. and two between the center and after 12-pdrs. They are to carry no torpedoes.

The engines are to be of 9,400 i. h. p. and to give a speed of 20 knots. The bunker capacity will be 600 tons.

RUSSIA.

BORODINO, IMPERATOR ALEXANDER III. AND OREL.

Of these first-class battleships, building at St. Petersburg, the first two were laid down May 25, 1900, and the third June 11, 1900, all having been in preparation for several months. They are similar in appearance to the *Jauréguiberry* of the French navy, and have the following dimensions: length, 397 feet; beam, 76 feet; draught, 26 feet; displacement, 13,600 tons.

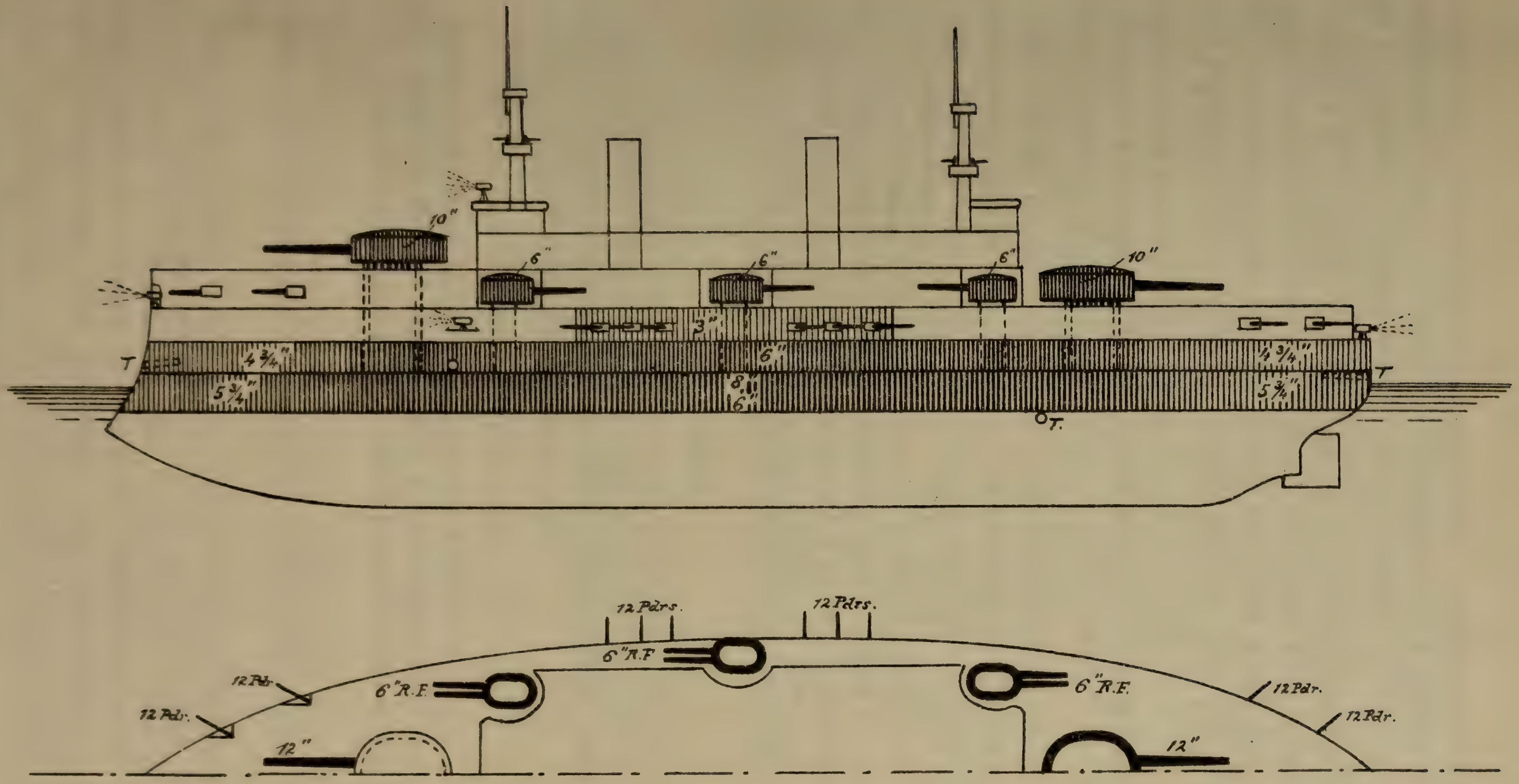
They differ from the prototype in having much lighter masts, smaller but taller smoke-pipes, and more extensive batteries.

The protection consists of a water-line belt of 8 inch Krupp steel, tapering to 6 inches at the lower edge and to 5.75 inches at the ends, being 6.5 feet wide and extending 1 foot 8 inches above the water line. At the stem the lower edge slopes down to the point of the ram. Above this belt is another of 6 inch Krupp steel tapering to 4.75 inches at the ends, and reaching 5.5 feet above the main belt. The central casemates, each containing six 12-pdrs., are situated under the central 6-in. turrets, and have a protection of 3 inch armor. There are two protective decks, the upper one flat, 2 inches thick, and joining the upper edge of the 6 inch belt. The lower one is made of two plates of $\frac{3}{4}$ inch steel. The amidships portion is flat and at the level of the upper edge of the main belt. It curves downward near the side, and is then vertical to tne inner sides of the frames at the bilge keels. This vertical portion extends forward and aft for a distance of 288 feet, being completed at the forward end by an athwartship bulkhead of the same thickness and at the after part by a curved bulkhead joining the two sides, forming an armored water-tight compartment below the water-line. Above the casemates the deck is armored with 2.5 inch steel outside, and 1.5 inch steel within the superstructure. Each turret has it own magazine. The turrets are elliptical, balanced on the French system; main turrets 10 inches thick; ammunition tube 8 to 9 inches; 6-in. turrets 6 inches thick; ammunition tubes 4 inches thick.

The armament consists of four 12-in. 40-cal. guns, in two turrets, forward and aft; twelve 6-in. R. F. guns of 45 calibers, in pairs, in six turrets; twenty 12-pdrs., twelve in casemates amidships, four in armored recessed ports forward, and four similarly placed aft; twenty 3-pdr. R. F. guns, four in each top, of which there is one on each mast, and twelve on the superstructure, and four Maxims.

There are six torpedo tubes, one in stem and on each bow behind the 6 inch belt, one in the stern behind the main belt, and two submerged tubes just forward of the after turret.

These vessels will carry 75 rounds for each 12-in. gun, 200 for each 6-in. gun, 300 for each 12-pdr., and 810 for each 3-pdr. gun.



BORODINO, RUSSIAN BATTLESHIP, 13,600 TONS.

There are two vertical, triple-expansion, four-cylinder engines, driving twin screws. The valves are cylindrical. The intermediate and low-pressure cylinders have the same diameter. The screws are not widely separated, nor is the deadwood cut away aft. The rudder is shipped in gudgeons, and balanced by a small portion extending under the bottom, as shown in the plan. It is fitted with an ordinary tiller, connected directly with the rudder head, and given motion by chain pulleys and chains from the steering engines. The main engines should develop 16,500 i. h. p., and give a speed of 18 knots. The maximum coal capacity is 1,500 tons.

There are five search-lights, one in bow and stern, two on main deck abreast foremast, and one on the bridge; no search-lights on the masts.

The complement will be 32 officers and 800 men.

There are 20 Belleville boilers in two compartments, 10 in each group, placed back to back, with two athwart-ship fire-rooms to each group. There is a magazine between the boiler-rooms, separated from them by transverse coal bulkheads. It was desired to place four of these boilers without economizers close up under the lower protective deck, the space below the boilers remaining vacant. This for the reason that the *Gangout* might have been saved if she could have supplied steam to her pumps from boilers so placed when the fire-rooms were flooded. The engineering department, however, says this is practically impossible.

KNIAZ SUVAROFF.

This new battleship of the *Borodino* class was to have been laid down in the shipyard at Galernia Island early in June, 1901, but its construction has been postponed on account of the fire which practically destroyed the plant at the yard June 13, 1901.

KNIAZ POTEMKIN TAVRITCHESKI.

This first-class battleship was launched at Nicolaief October 9, 1900, and is similar to the *Tri Sviatitelia* in general appearance, but much improved in armor and armament. She is to form a part of the Black Sea fleet.

Her dimensions are: length between perpendiculars, 370 feet 8 inches; beam, 73 feet; mean draught, 27 feet; displacement, 12,500 tons.

She is built of steel, is well subdivided, has double bottom nearly the entire length, wing passages above the protective deck behind the belt armor, and bilge keels. She is not sheathed. She has two military masts, the forward one being the higher of the two, three elliptical smoke-pipes, with the longer axes athwartships, a raised forecastle, and a ram bow. She is fitted with two heavy cranes for handling the boats, which will include two 13-ton torpedo boats, fitted to launch 15-in. Whitehead torpedoes.

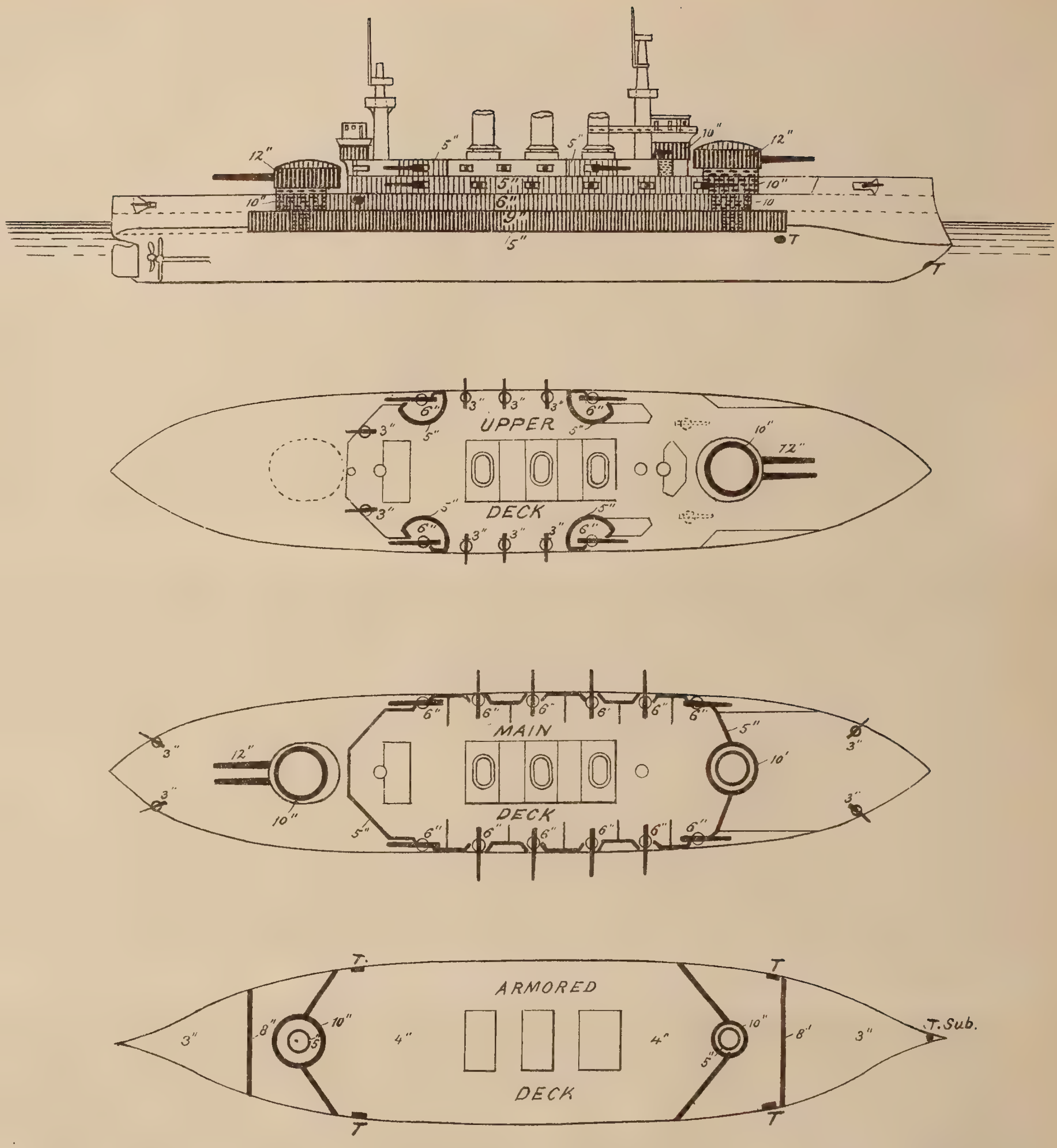
The protection, all of Krupp steel, consists of a main belt 7 feet 6 inches wide, 9 inches thick at the top and 5 inches thick at the bottom, the upper edge being 3 feet above the water-line. This covers 250 feet of her length, and is terminated by transverse bulkheads 8 inches in thickness.

The protective deck joins the lower edge of this belt and is 4 inches in thickness over the vitals of the vessel and 3 inches at the ends, and extends well above the water-line, about to the height of the upper edge of the water-line belt. Above this belt is a second one, 6 inches in thickness and 7 feet 5 inches wide, and above this again is a third belt, 5 inches in thickness and 7 feet 6 inches wide, covering the main deck guns. The turrets are slightly elliptical, balanced and protected by 12 inches of steel, and the turret pivot by 10 inches of steel down to the level of the water-line belt, below which the protection is 5 inches. There are conning towers forward and aft, both 10 inches in thickness and the communication tube is 5 inches in thickness.

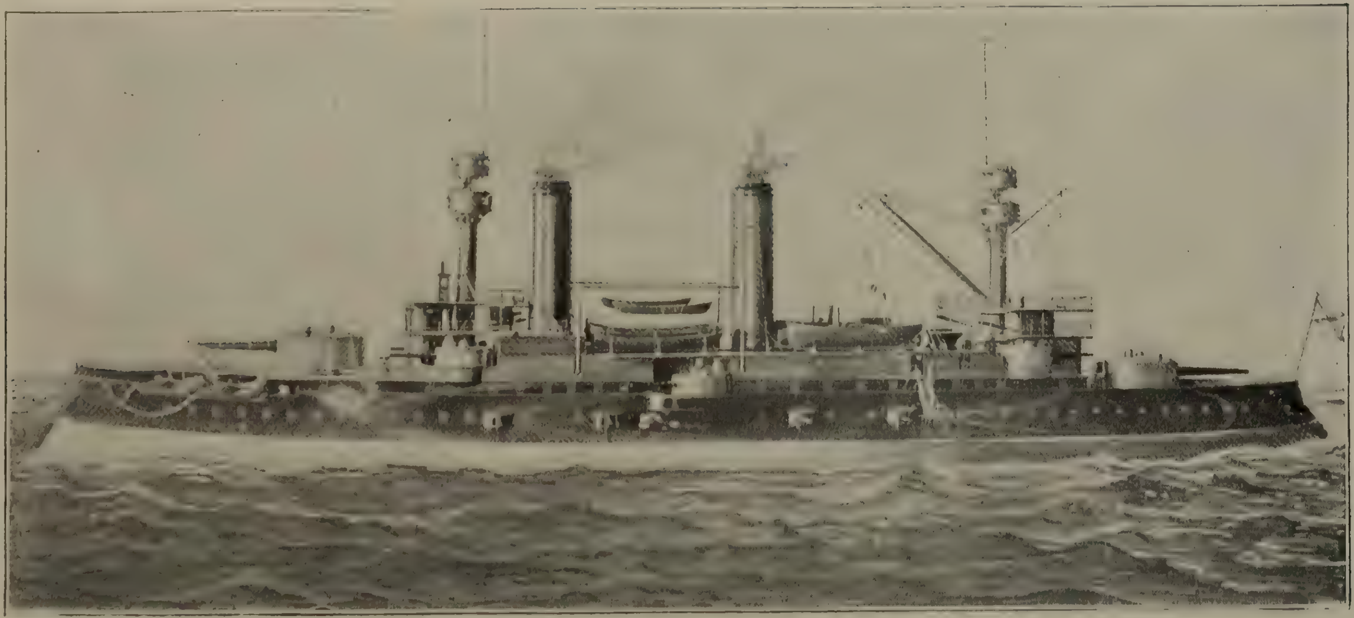
The armament consists of four 12-in. 40-cal. guns in two turrets, forward and aft, those in the forward turret having an arc of fire of 200 degrees, while those in the after turrret have an arc of fire of 260 degrees; sixteen 6-in. 45-cal. R. F. guns, twelve in a redoubt on the main deck, separated by splinter bulkheads, 2 inches in thickness, the forward and after guns having arcs of fire of 135 degrees from the fore and aft line, and the other guns arcs of fire of 115 degrees alternately from a bow and a quarter bearing, all being protected by heavy circular shields, the remaining four being carried on the upper deck above the third armor belt in closed casemates, 5 inches in thickness, and with the same arcs of fire as the 6-in. guns in the corners of the redoubt below; fourteen 12-pdr. R. F. guns, of which six are on the upper deck between the 6-in. casemates just mentioned, without protection. with arcs of fire of 90 degrees, from bow to quarter, four are in the forward and after ends of the superstructure with arcs of fire of 100 degrees, and the remaining four are in recessed ports on the main deck, two forward and two aft, with arcs of fire of 120 degrees from the fore-and-aft line; twenty 1-pdr. R. F. guns mounted in the tops and on the bridges and superstructure. There are five torpedo tubes, one in the stem, submerged, one on each beam, forward of the forward turret, also submerged, and one on each side just abaft the main mast, behind the 6 inch armor. She is also fitted with torpedo-defense nets.

She will be fitted with two vertical triple-expansion engines capable of developing 10,600 i. h. p. and giving a speed of 18 knots. There will be twenty-four Belleville boilers in three compartments, fitted with economizers and arranged to burn oil.

Her bunkers are designed to carry 600 tons of oil and 670 tons of coal, the latter being in wing bunkers near the boilers and the former



KNIAZ POTEMKIN TAVRITCHESKY, RUSSIAN BATTLESHIP, 12,500 TONS.



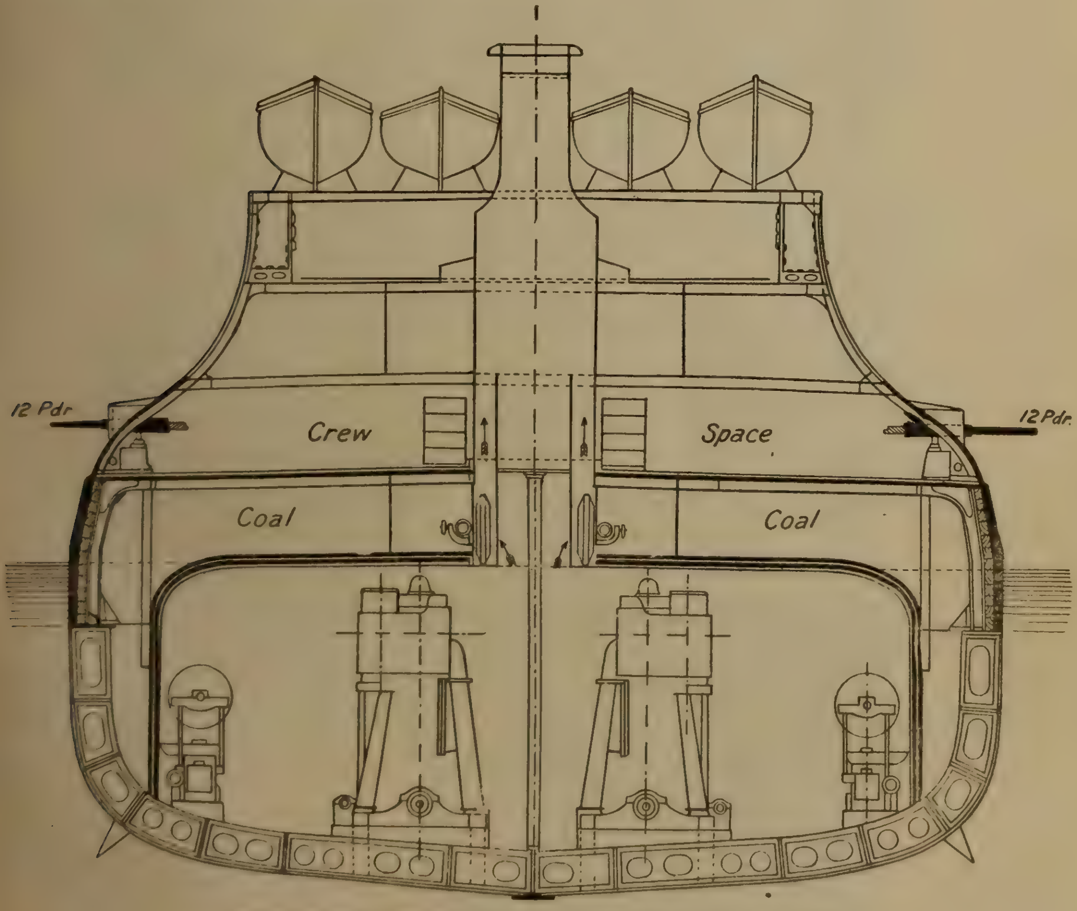
TSAREVITCH, RUSSIAN BATTLESHIP, 12,900 TONS.

in forward and after bunkers below the protective deck. She can also, in case of necessity, take 200 tons of coal in the double bottoms. The furnaces will be fitted for burning oil, but so arranged that within about an hour they may be changed to coal burning furnaces.

The complement will be about 600, officers and men.

TSAREVITCH.

This battleship, built at La Seyne, laid down May 18, 1899, and launched February 23, 1901, is similar to the *Borodino* class, just described, but a little smaller and lacks the armor protection for the 12-pdr. guns in the bow and stern.



CROSS SECTION OF TSAREVITCH THROUGH ENGINE ROOMS.

Her dimensions are: length, 388 feet 9 inches; beam, 76 feet 1 inch; draught, 26 feet; displacement, 12,900 tons.

ADMIRAL BUTAKOFF.

This new coast-defense ship of the type of the *General Admiral Apraksin* is reported to be building at St. Petersburg. Her dimensions are to be: length, 341.5 feet; beam, 59.25 feet; draught, 17.25 feet; displacement, 5,985 tons.

She is to have an armor belt all along the water-line, the maximum thickness of which is 7 inches above and 5 inches below throughout the most vital parts, diminishing at the bow and stern to 4 inches. The protective deck is 1 inch thick, but over the engines and boilers it increases to 2.25 inches. The turrets have 6 inch armor and the ammunition tubes 5.5 inches.

Her armament will consist of six 8-in. 45-cal. guns in pairs in the turrets forward and aft, and one in each turret amidships; sixteen 3-pdr. R. F. guns, eight in an armored casement and the others distributed about the ship; four Maxims and six torpedo tubes, two of which will be submerged.

She will have two triple-expansion engines capable of developing 7,000 i. h. p., and giving a speed of 16 knots. Steam will be supplied by twelve Belleville boilers with economizers. Her coal supply will be 583 tons, giving her a radius of action of 750 miles at full speed and 1,400 miles at 10 knots. Her complement will consist of 472 men.

BAYAN.

This armored cruiser, described in General Information Series No. XIX, page 67, was laid down at La Seyne July 11, 1899, and launched June 12, 1900. In addition to what has been there noted, she has three above-water torpedo tubes, and carries four search-lights, one in the foretop, one low on the mainmast, and one on each side amidships, carried above the central battery.

The ammunition carried is as follows: For each 8-in. gun, 100 rounds; each 6-in. gun, 150 rounds; each 12-pdr., 250 rounds, and each 3-pdr., 500 rounds.

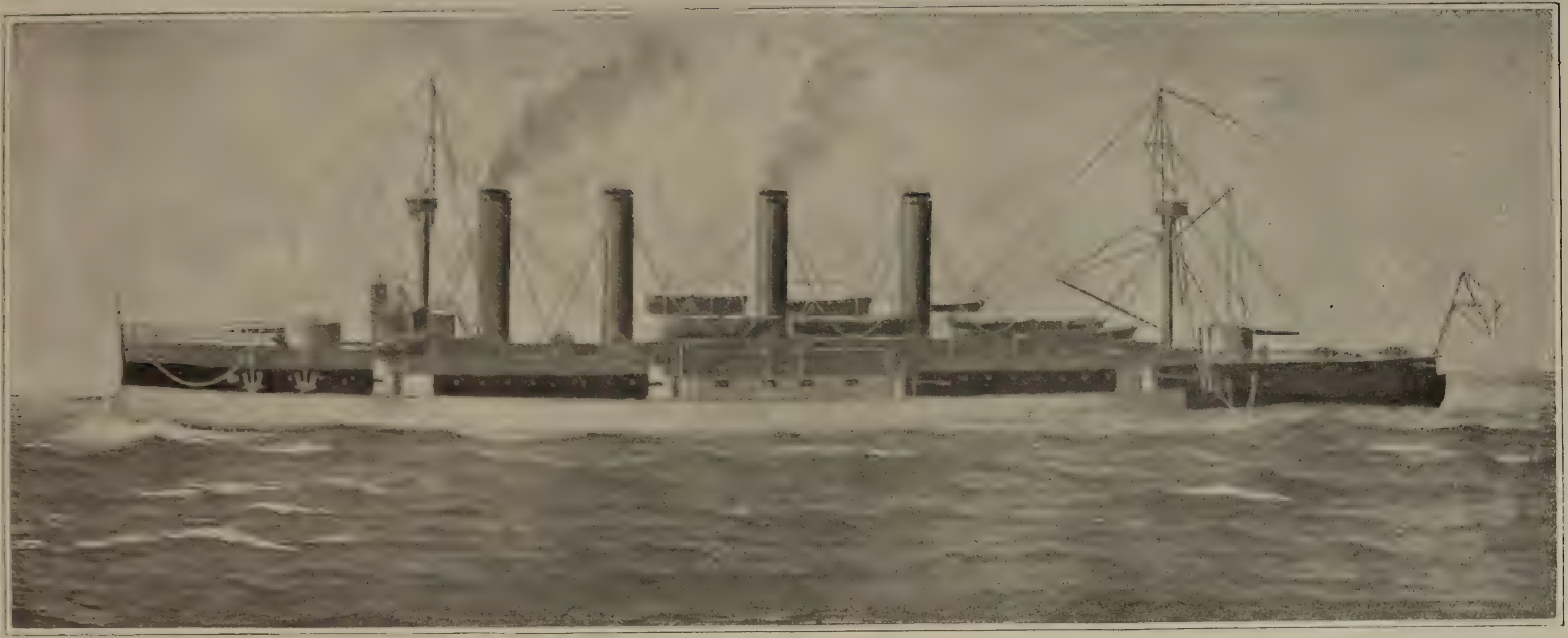
BOGATYR.

This first-class protected cruiser, built at Stettin, was laid down December 22, 1899, and launched January 30, 1901, and is of the class of the *Varyak*, built in Philadelphia, but differs in the distribution and protection of the armament, and has other interesting features in her design.

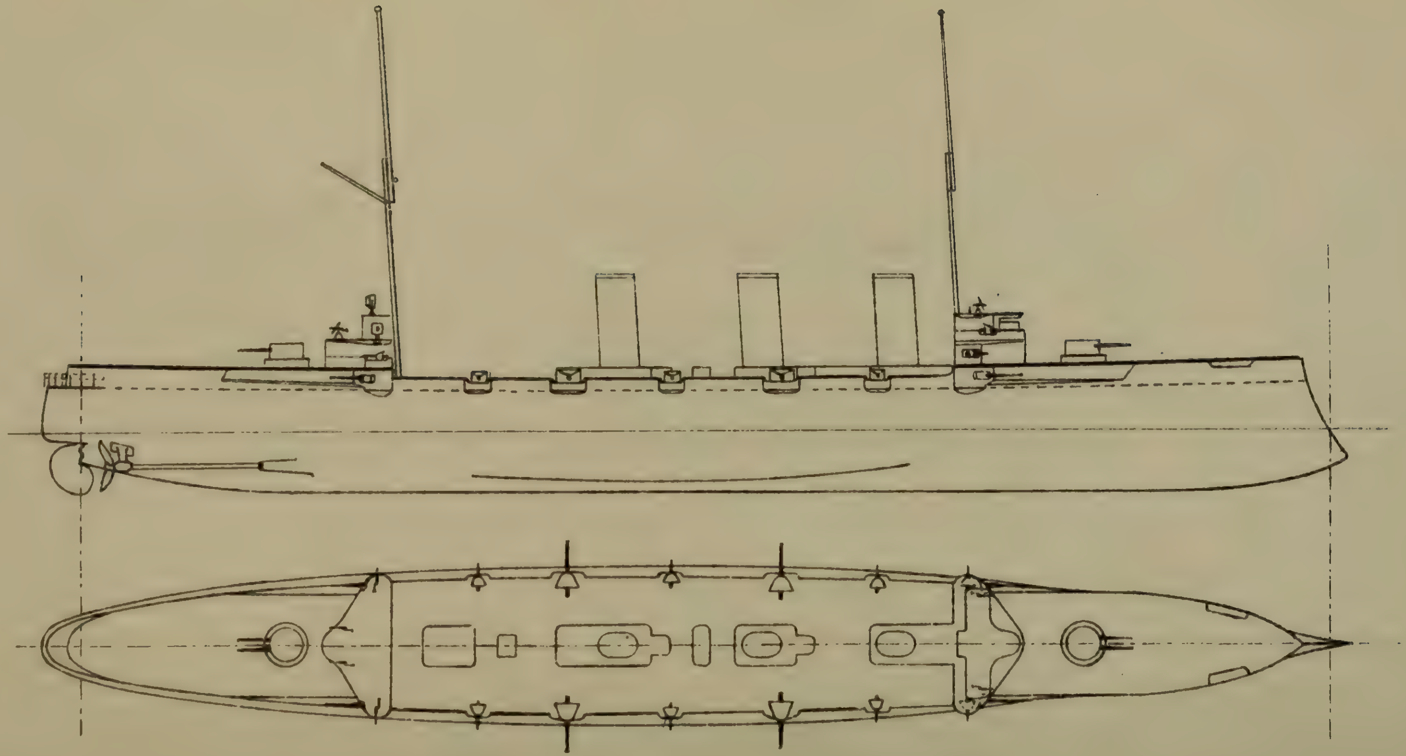
Her dimensions are: length over all, 440 feet 2 inches; length at water line, 433 feet; beam, 54 feet 5½ inches; depth, 34 feet 1½ inches; draught, with complete equipment and 720 tons of coal on board, 20 feet 10 inches; displacement, 6,500 tons.

She is built of the best German steel. The hull of the ship is divided into numerous water-tight compartments. The middle part of the vessel, in which the engines, boilers, and ammunition rooms are placed, has a double bottom which extends up the sides to the height of the armor-plated deck.

The vessel has two masts with signal yards, three smokepipes, and has a raised forecastle and poop. Six search-lights are placed on special bridges, two on the forward bridge, two on a special bridge forward, and two aft.



BAYAN, RUSSIAN ARMORED CRUISER, 7,800 TONS.



BOGATYR, RUSSIAN PROTECTED CRUISER, 6,500 TONS.

The vital parts of the vessel are protected by an armored deck extending over the whole vessel. The openings in the deck are covered by gratings or water-tight hatch covers. The armor-plated deck has a thickness of 1 inch in the horizontal center parts. The sloping parts of the deck have a thickness of 2.75 inches, and 2.1 inches at the ends. The armored deck consists of two plates screwed together, of which the upper layer is of nickel steel.

For the protection of the commander there is a conning tower on the forward bridge. The armored plates of the tower are 5.5 inches thick, the screen is 3.5 inches thick, and both are of hard nickel-steel. The signal wires, etc., running from the towers are protected by an armored tube.

The armament comprises twelve 6-in. 45-cal. R. F. guns, four in turrets forward and aft, four in casemates, two forward and two aft, and four in broadside; twelve 12-pdr. 50-cal. R. F. guns, and six 3-pdr. Hotchkiss R. F. guns. For boat and landing purposes there are one 9-pdr. Baranowski gun and two Hotchkiss guns.

Eight of the twelve 6-in. guns are protected by armor plating. One pair of the 6-in. guns is placed aft, and one pair forward in turrets. Four of the 6-in. guns, which can be fired broadside and forward and aft, are placed in casemates on the upper deck. The turrets of the 6-in. guns are protected with an armor of 5 inches at the front and 3.5 inches at the back. The 5 inch plates are of hard steel; those of 3.5 inches of nickel-steel. The ammunition hoists under these casemates are protected by an armor of nickel-steel 3 inches in thickness. The casemates for the 6-in. guns are protected by nickel-steel plates, the front plates being 3.15 inches thick and the back ones 1.4 inches. The four ammunition hoists to the casemates are protected by 2.4 inches of nickel-steel plating. The other guns are protected by armored shields.

There are large ammunition rooms and the ammunition is put up in cases, in accordance with the Russian system.

For the quick supply of ammunition there are the following hoists: Two hoists for the 6-in. turrets, four for the 6-in. casemates, two for the 6-in. guns on deck, three for the 12-pdr. guns, and two for the 3-pdr. guns. These hoists can be worked by electricity or hand. The vessel will have six torpedo tubes, of which two will be submerged. The guns and ammunition, the turrets, as well as their ammunition hoists and turning machinery, also the whole of the torpedo armament, were supplied by the Russian navy.

The vessel has two propellers, each being worked by a triple-expansion engine with four cylinders. The two engines are estimated to develop 20,000 i. h. p. and give a speed of 23 knots. The moving parts of the main engines are balanced on Schlick's system.

There are 16 Normand boilers, having a working pressure of 270 pounds per square inch, a total heating surface of 49,496 square feet, and fitted for forced draft.

The vessel will be well ventilated, heated by steam, and lighted by electricity. There are four large and two small dynamos driven by steam which supply the power for the electric light, the ammunition hoists, the extensive ventilating machinery, and six search-lights. The steering apparatus, windlasses, boat-hoisting gear, pumps, etc., will be worked by steam. The vessel carries two steamboats, one petroleum-motor boat, and seven rowing boats. The boats are all built of thin steel, except the small rowing boats.

The coal bunkers, which can hold 1,100 tons, are placed partly above and partly below the armored deck. The vessel will have a radius of action of 5,000 miles at a speed of 10 or 11 knots.

She will carry 23 officers and 550 men, for whom high and airy quarters have been provided. The use of wood throughout the vessel has been cut down to the smallest possible limits. All decks are of steel, and only the exposed ones are planked with teak to protect them from climatic influences. The inner decks are covered with linoleum. Most of the furniture is built of thin steel, also all the cabin partitions.

BOYARIN.

This second-class protected cruiser, building at Copenhagen, was laid down September 6, 1900, and launched June 8, 1901.

She is similar in dimensions to the *Novik*, to be described hereafter, but her internal fittings, machinery, etc., will be different. She will have two masts, the foremost carrying a fighting top for machine guns.

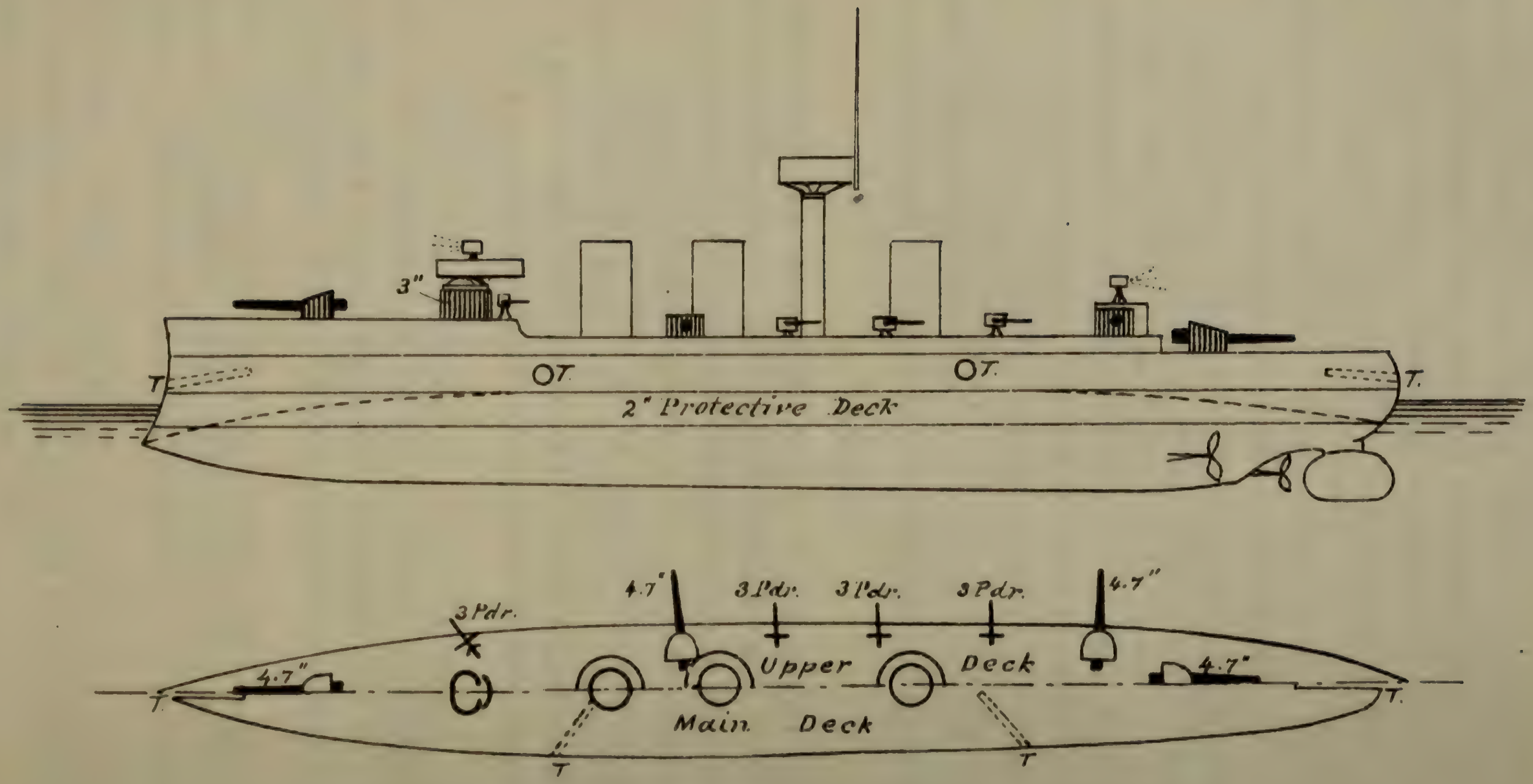
The protection of the vessel consists of a protective deck 2 inches and 1.2 inches thick carried almost the whole length of the vessel, and there will be an armored conning tower and armored ammunition-hoists from the magazines.

The armament will comprise six 4.7-in. R. F. guns, two in sponsons on each broadside, one on the forecastle and one on the poop; eight 3-pdr. R. F. guns, two on each broadside and two forward and two aft on the upper deck. There will be one stern and four broadside torpedo tubes.

There will be two sets of four-cylinder triple-expansion engines. Diameters of cylinders, 28.25, 44.25, and 51 inches, with a stroke of 30 inches. They are to develop 11,500 i. h. p. and give a speed of 22 knots.

The boilers are of the latest Belleville type with economizers. There will be three boiler-rooms containing 16 of these boilers working at a pressure of 320 pounds per square inch.

The vessel will be fitted with all the latest types of auxiliary machinery for pumping, distillation, electric lighting, search-lights, hoists, winches, windlass, etc. As to boats the ship will be supplied with two steam launches and six boats of various sizes. The complement



NOVIK, RUSSIAN PROTECTED CRUISER, 3,200 TONS.

of the vessel will be about 340 men. Ample accommodation for the officers will be provided in the poop, the crew being accommodated on the main deck and in the forecastle.

NOVIK.

This second-class protected cruiser was laid down at Danzig August 12, 1899, and launched August 15, 1900.

Her dimensions are: length over all, 348 feet; beam, 40 feet; draught, 16 feet; displacement, 3,200 tons.

She is built of steel with exceedingly fine lines to give her high speed, has a ram bow, raised forecastle, three smoke-pipes, and one mast, with fighting top and signal yards, between the middle and after smoke-pipes. Three search-lights are carried. The deadwood is much cut away aft and there is no shoe. The balanced rudder is suspended without support underneath, and is sharp on forward and after edges.

The protective deck extends from stem to stern in a curve, is sloped toward the sides, and reaches from 1.3 feet above to 4.25 feet below the water-line. It is 2 inches thick on the slopes, from 1.2 to 0.6 inches on the horizontal portions, and is raised in dome-shaped form over the two engine-rooms. Here the slopes are 2.75 inches thick.

The armament comprises six 4.7-in. R. F. guns in shields, one on forecastle and poop, and four in broadside on the upper deck; eight 3-pdr. R. F. guns, six in broadside on the upper deck and two on forecastle abaft the bridge; two Maxims, and six above-water topedo tubes, one in bow and stern and two on each broadside.

The most marked peculiarity of the ship is the high engine efficiency of 18,000 i. h. p., for a speed of 25 knots. The small draught of the ship necessitated the division of the power among three engines of equal efficiency and three screws. The circle of revolution of the center screw cuts the prolonged line of keel, although its diameter is less than that of the wing screws. The latter are three-bladed, while the center one is four bladed. There are three four-cylinder, triple-expansion engines. That for the center screw is farthest aft. Adjoining this forward is a fire room with four Schichau boilers. Then come the other engines side by side, but separated by a longitudinal bulkhead. Forward of these are two boiler-rooms, each containing four Thornycroft boilers, separated by a transverse bulkhead.

The maximum coal capacity is 500 tons, giving a radius of action of 6,000 miles.

The complement is about 300, officers and men.

On account of her high speed and other qualities, this vessel has been called a destroyer of torpedo-boat destroyers.

She has good sea-keeping qualities, besides guns and protection, and speed that will render her a dangerous opponent for any torpedo-boats or destroyers which may stray into her vicinity. In a seaway she will be able to travel even faster than a flotilla of destroyers, each a tenth her size and more than proportionately fragile and liable to overstrain or worse. While destroyers carry only a few 12-pdrs. and 3-pdrs., this ship carries 4.7-in. R. F. guns; and six torpedo tubes give her greater offensive power with this weapon than any other vessel afloat. There is no reason to think she will not realize all anticipations.

It is reported that two others of this class are building at St. Petersburg.

ASTRABAD.

This gunboat, for service on the Caspian Sea, was laid down at the Sormov works, Nizhni Novgorod, on the Volga, in 1899, and launched in 1900.

Her dimensions are: length, 126 feet; beam, 22 feet; draught, 7.5 feet; displacement, 326 tons.

The hull is built entirely of Russian material, and is divided into water-tight compartments by 6 transverse bulkheads, which extend to the upper deck, and by 4 half-bulkheads. The double bottom extends through the engine and boiler rooms to the height of the floor, and consists of steel plate $\frac{5}{32}$ inch thick. At the stem and stern, at a distance of 6 feet 4 inches from the upper deck, the interior bottom consists of fir planks. With regard to water-tightness, all compartments are to be tested under pressure.

In view of the fact that the vessel will make use exclusively of naphtha as fuel, special tanks for this liquid have been constructed on the vessel for a two days' run, calculated at a speed of 12 knots an hour. At the stern, abaft the engine room, accommodation has been arranged for the commander and five officers, with a mess room, pantry, bathroom, and water-closet, while accommodation for 25 men of the crew has been arranged forward. The hold in the stem has been arranged for provisions, etc., and in the stern, tanks for drinking water. Independently and forward of the boiler room, between the steel bulkheads, a magazine has been built for the ammunition of the vessel.

The water exhaust system consists, apart from the means afforded by the engines, of a 5 inch Stone's pump, placed between the main bulkheads. The pumps are supplied with hose in case of fire.

The vessel will be supplied with the following boats: a steam launch 25 feet 7 inches long, a six-oared whaleboat 28 feet long, a six-oared yawl 20 feet long, a four-oared yawl 17 feet 3 inches long, and two sail boats.

The armanent will consist of four 6-pdr. and six 3-pdr. R. F. guns.

She is fitted with two compound engines with surface condensers, each engine developing 250 i. h. p., actuating two screws. The diameter of the high-pressure cylinders is 16 inches, and of the low-pressure cylinders 28 inches; piston stroke, 16 inches. The speed is to be 12 knots.

The high-pressure cylinder is supplied with piston valves, and the low-pressure cylinder with slide valves. The cooling surface of the condenser is 1,100 square feet.

There are two cylindrical boilers, 10 feet 2 inches long and 9 feet 9 inches in diameter, which have two furnaces, with a total heating surface of 2,000 square feet, and a working steam pressure of 120 pounds.

BAKLAN.

This torpedo-boat destroyer, one of nine vessels building at the Neva Works, St. Petersburg, and named, respectively, *Baklan*, *Bekass*, *Gorlitza*, *Gratch*, *Kubik*, *Perepel*, *Skvorets*, *Stchegol*, and *Stvige*, was launched in July, 1900.

The dimensions are: length, 210 feet; beam, 21 feet; draught, 2 feet 10 inches; displacement, 350 tons.

The propellers are protected as in vessels of the *Sokol* type, and the steering apparatus and its protection are of forged steel.

The armament consists of one 12-pdr. R. F. gun and five 3-pdr. R. F. guns, with three torpedo tubes.

There are two vertical triple-expansion engines, with three cylinders to develop 4,500 i. h. p. and give a speed of 26 knots. The diameters of the cylinders are, high-pressure, 20½ inches; intermediate, 31½ inches; low-pressure, 34 inches, the cylinders being of iron cast in one piece.

The propellers have three blades of manganese bronze and the outer surface of the screws will be fitted with the Williams apparatus. The boilers are of the Yarrow type, four in number, their united heating surface being about 12,800 square feet, while the grate surface is 240 square feet, and the working pressure 250 pounds. The coal capacity is 80 tons.

Each of their compartments will be fitted with a turbine capable of ejecting 80 tons of water an hour, and there will also be seven 5 inch hand pumps, each worked from the upper deck.

The electric lighting is accomplished by a steam-driven dynamo of 100 ampères and 100 volts. The deck is lighted by 40 incandescent lamps. The projector is of 24 inches.

FOREL AND CLASS.

There are five torpedo-boat destroyers building in France for the Russian Government. The class comprises the following vessels:

Name.	Built at—	Launched.
Forel	Havre	Dec. 8, 1900
Kefal	La Seyne	
Losos	do.	
Osetr	do.	Jan. 23, 1901
Sterliade	Havre	Mar. 8, 1901

Their dimensions are: length, 186 feet; beam, 21 feet; draught, 13.5 feet; displacement, 312 tons; i. h. p., 5,700; speed, 26 knots.

They are similar to French vessels of the same class, and every endeavor is being made to combine great lightness with as much strength as possible, the method of securing the hulls, decks, and compartments, and the quality of the material used contributing largely to this result. All the side plating and angle steel is made of a special nickel-steel with a high resistance to projectiles, the proportion of nickel being 4 per cent. In spite of the difficulty of working with the material, the work has been done with great neatness. The sheathing is zinced under water and to a certain height above the water-line. There are nine water-tight bulkheads, made of steel in the same way as in the battleships, and they will be subjected to a severe test.

The armament will comprise one 12-pdr. R. F. gun on the conning tower, five 3-pdr. R. F. guns on deck, and two torpedo tubes.

There are two vertical triple-expansion engines, which are to be tested at a pressure of 315 pounds per square inch, and at the full speed of 26 knots should develop 4,750 i. h. p. for the two engines at 310 revolutions per minute.

There are to be four water-tube boilers of the Normand pattern to each. The tubes of the boilers are to be of the softest steel without welds. The hulls under the boilers and engines have been strengthened with riders and specially strong frames and keelsons.

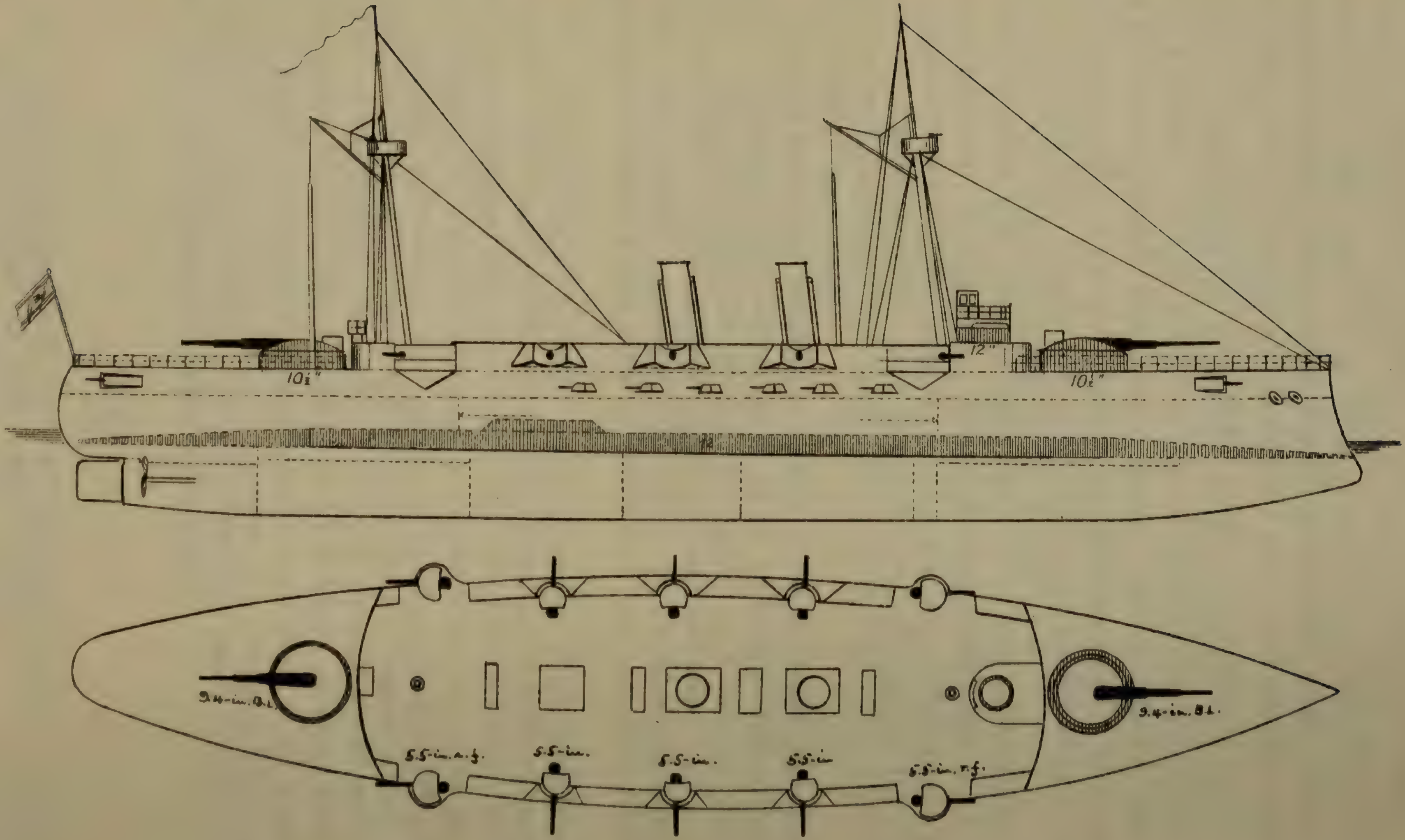
The water-ejecting apparatus will consist of a centrifugal pump, eight steam ejectors with a capacity of 100 tons per hour, and two of 20 tons.

The vessels will be subjected to unusually severe tests before being accepted. The trials include one of eight hours at 14 knots to ascertain the coal consumption, after which there is to be a six hours' trial at full speed. This is to be followed by a speed trial of 22 knots, during which the behavior of the engines is to be carefully noted, and within two hours of the end of this trial the boats are again to make a spin under full speed for two hours. There is a penalty of $3,000 for each quarter knot less than 26 and down to 25 knots, at which a penalty of $5,000 is imposed for each quarter knot down to 24 knots, which latter is the lowest limit for acceptance. A miscalculation or a breakdown may thus cost the contractors $32,000, which would more than wipe out the profit on the $300,000 contract.

SPAIN.

CATALUÑA.

This armored cruiser, laid down at Cartagena, January 23, 1890, was launched September 24, 1900. She is similar to the *Cardinal Cisneros* and *Princesa de Asturias*, which are still completing, though launched in 1897 and 1896, respectively. All are of the type of the *Infanta Maria Teresa.*



CATALUNA, SPANISH ARMORED CRUISER, 7,000 TONS.

Their dimensions are: length between perpendiculars, 347 feet 10 inches; length over all, 364 feet; beam, 60 feet 10 inches; draught, 22 feet; displacement, 7,000 tons.

They are built of steel with ram bow, carry two light masts with small tops for light machine-guns, have two smoke-pipes in fore-and-aft line, poop and forecastle on same level, and a central superstructure for the auxiliary battery. The use of wood has been avoided wherever possible.

They are protected by a water-line belt 230 feet long and 6 feet wide of nickel steel 12 inches thick amidships and tapering to 10 inches at the extremities, and by a protective deck 2 inches thick on the flat, and 2.75 inches on the slopes, and there is coal protection above and abreast the engines. The conning tower forward of the foremast is 12 inches thick.

The armament comprises two 9.4-in. guns in barbette turrets, forward and aft, the turrets being 10.5 inches thick with lighter covers; ten 5.5-in. R. F. guns in the spardeck superstructure in separate casements, the forward and after guns being in sponsons to have a fire ahead and astern, respectively, the guns carrying cylindrical shields, which completely close the ports; two 12-pdr. and eight 6-pdr. R. F. guns in broadside on the main deck below the 5.5-in. battery, and four 1-pdr. R. F. guns for the tops and bridges. There are five submerged torpedo tubes.

There are two vertical triple-expansion engines, driving twin screws, to develop 10,000 i. h. p. with natural draft and 15,000 i. h. p. with forced draft, giving a speed of 18 and 20 knots. They will have water-tube boilers. The maximum coal capacity will be 1,200 tons, giving a radius of action of 10,000 miles at 10 knots.

Four search-lights are provided. The rudder will be balanced and actuated by a steam steerer or by hand.

It is reported that she will carry a torpedo boat 91 feet long, of 18 knots speed, with rapid-fire armament; two 42 foot launches with torpedo launching gear, speed of 12 knots and rapid fire guns, and eight other boats.

REINA REGENTE.

This protected cruiser, building at Ferrol, laid down March 27, 1897, will be of the following dimensions: length, 337 feet 10 inches; beam, 52 feet 6 inches; draught, 19 feet 9 inches; displacement, 5,370 tons.

She will have a protective deck 3.1 inches thick and carry two 7.8-in. guns in turrets; eight 5.9-in. R. F. guns in casemates; twelve 6-pdr. R. F. guns, and eight 1-pdr. Maxim automatic guns.

Her engines are to develop 6,500 i. h. p., and give a speed of 20 knots.

Two School Ships.

Two school ships have been ordered built in Spain by contract. They are to be of Siemens-Martin steel, with double bottoms, have a displacement of 2,500 tons, be ship-rigged, with double topsails, have auxiliary triple-expansion engines, capable of giving a speed of 12 knots, and a sufficient coal capacity to give a radius of action of 2,000 miles. They will have two groups of boilers, one of the Belleville type and the other "express" boilers with tubes of small diameter.

The armament will consist of eight 6-pdrs., two smaller guns and two torpedo tubes.

They will be lighted by electricity, have two search-lights and motors to work the ammunition hoists.

SECTION III.

STEAM TRIALS.

DENMARK.

HERLOFF TROLLE.

This coast-defense ironclad had her preliminary trials in March, 1901. With 3,171 i. h. p., she made 14.59 knots, and with 4,399 i. h. p., 15.65 knots.

ENGLAND.

ALBION.

The official results of the thirty hours' trial at one-fifth power of the first-class battleship *Albion*, on December 5, 1900, are as follows: Draught forward, 26 feet 6 inches, aft, 26 feet 6 inches; steam in boilers, 241 pounds; vacuum in condensers, starboard, 27.1, port, 26.9; revolutions per minute, starboard, 66.4, port, 65.8; mean i. h. p., starboard, 1,329, port, 1,393, total, 2,772; speed, 11.2 knots; consumption of coal, 2.17 pounds per horse-power-hour. The trial was satisfactory.

On March 15, 1901, she completed a thirty hours' trial at four-fifths power, the machinery and boilers having worked smoothly during the whole of the trial. The mean results were as follows: steam in boilers, 244 pounds, at engines, 199 pounds; vacuum in condensers, starboard, 27.7, port, 27; revolutions per minute, starboard, 102.6, port, 101.8; i. h. p., starboard, 5,294, port, 5,515, total, 10,809; speed, 16.8 knots; consumption of coal, 1.8 pounds per horse-power-hour.

On March 28, 1901, she completed her trials with an eight hours' trial at full power under natural draft, in a gale of wind and a heavy sea. The steam pressure in boilers was 257.5 pounds, at engines, 226.5 pounds; vacuum, 27.3 inches; the power developed was 13,885 i. h. p., and the speed, 17.8 knots; coal consumption, 1.9 pounds per horse-power-hour. The engines worked very satisfactorily and no trouble was experienced with the Belleville boilers.

BULWARK.

This first-class battleship had her first thirty hours' trial at one-fifth power May 20 and 21, 1901. Eight of her twenty-four Belleville boilers were in use and the following results were attained: revolutions, starboard, 65.7; port, 66.3; i. h. p., 3,174; average speed, 11.2 knots; coal consumption, 1.78 pounds per horse-power-hour.

On May 23 and 24, 1901, she had her thirty hours' trial at four-fifths power. The mean results were: steam in boilers, 257 pounds; steam at engines, 240 pounds; vacuum, 27 inches; i. h. p., starboard, 5,987; port, 5,768; total, 11,755; revolutions, 101; speed, 16.8 knots; coal consumption, 1.8 pounds per horse-power-hour.

On May 27, 1901, she completed her series of trials with a full-power trial of eight hours' duration. The mean results were: steam in boilers, 281 pounds; steam at engines, 258 pounds; vacuum, starboard, 26.4 inches; port, 26.3 inches; revolutions, starboard, 109.6; port, 110; i. h. p., starboard, 7,695; port, 7,658; total, 15,353; speed, 18.15 knots; coal consumption, 1.83 pounds per horse-power-hour.

FORMIDABLE.

This first-class battleship completed her first thirty hours' trial at one-fifth power on March 29, 1901. The draught of water forward was 26 feet 3 inches; aft, 27 feet 3 inches; steam pressure, 233 pounds; vacuum, 27 inches, both engines; revolutions, starboard, 65; port, 65.4; collective i. h. p., 3,262; mean speed, 11.5 knots; coal consumption, 2.02 pounds per horse-power-hour.

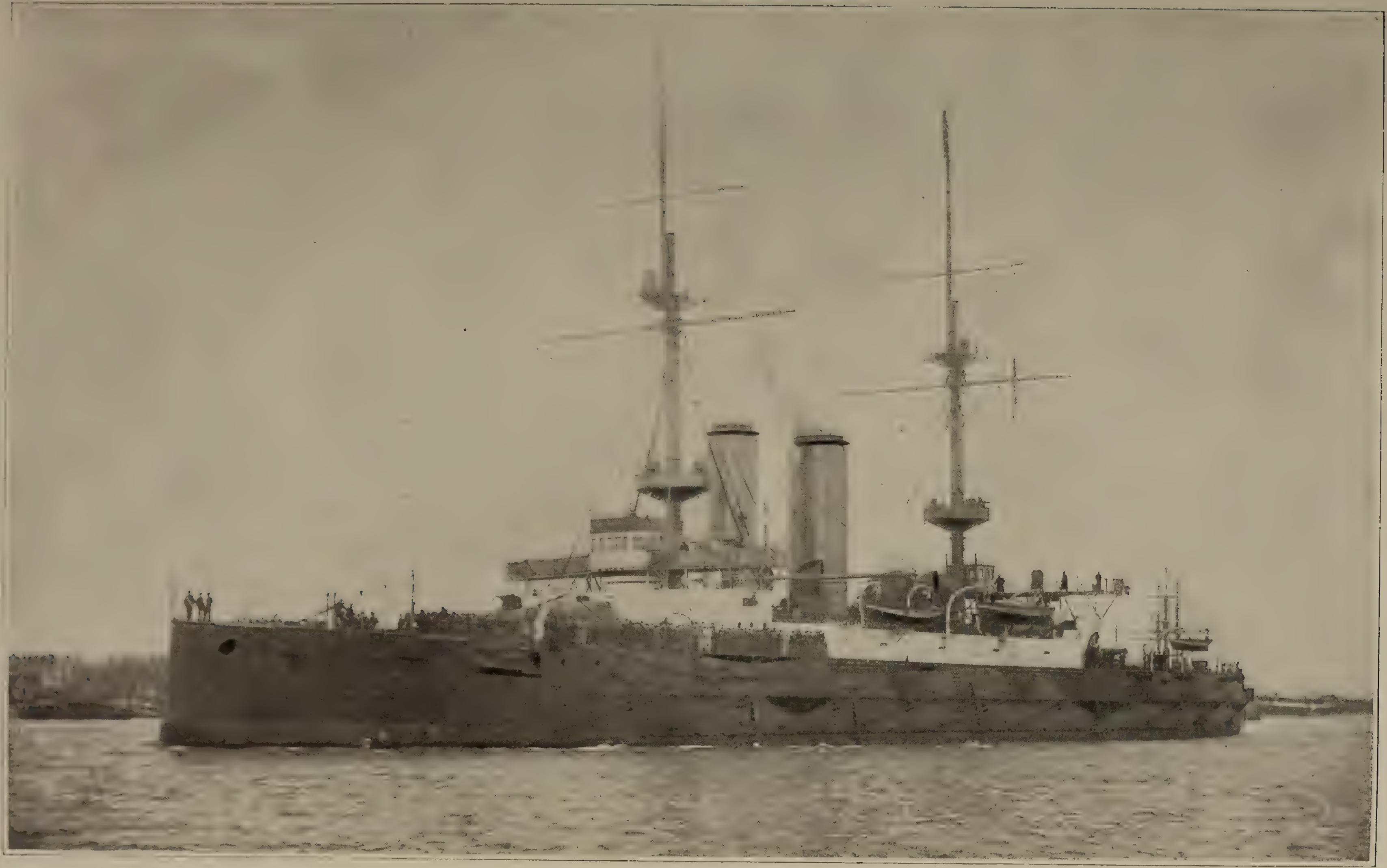
During the trial some leaks developed in the joints of the steam pipes, but the contractors did not think they were of sufficient importance to justify a delay of the second trial. The Admiralty, however, thought differently, and ordered the defects made good at once, which delayed the resumption of the trial some ten weeks.

On June 8, 1901, she completed her thirty hours' trial at four-fifths power successfully. The draught of water forward was 26 feet 6 inches; aft, 27 feet 10 inches. All the boilers were in use. Steam pressure in boilers, 257 pounds; vacuum, starboard, 26.3 inches; port, 26.8; revolutions, starboard, 100.2; port, 101.7; i. h. p., 11,618; speed, 16.81 knots; coal consumption, 1.89 pounds per horse-power-hour.

On June 13, 1901, she completed satisfactorily her eight hours' trial at full power with the following results: draught forward, 25 feet 4 inches; aft, 27 feet 4 inches; steam in boilers, 280 pounds; revolutions, starboard, 109.1; port, 109.6; i. h. p., starboard, 7,765; port, 7,746; total, 15,511; air pressure in fire-rooms, 0.18 inch; speed, mean of six runs over the measured mile, 18.13 knots; coal consumption, 1.8 pounds per horse-power-hour.

IMPLACABLE.

This first-class battleship commenced her trials on January 17, 1901. She was laid down July 13, 1898, and her progress was so rapid that she was launched March 11, 1899. The weight of the material worked into the structure up to the date of her launching was 5,300 tons, and as she was two days less than eight months on the stocks a record for rapid building was created.



FORMIDABLE, ENGLISH BATTLESHIP, 15,000 TONS

She went out of Plymouth Sound on the 15th of January, 1901, to adjust her compasses. Soon after leaving her moorings it was found that she answered her helm very quickly, and, as a consequence of this, she got very near the rocks at the entrance to the Hamoaze. Later, as she was leaving the sound, she turned so smartly that it seemed almost impossible to avoid a collision with the war department steamer *Sir Redvers Buller.* In spite of every effort she actually touched the steamer, but with trifling damage.

The first trial run was made between Plymouth, the Start, and about 40 miles west of Scilly, and from the time the battleship left the sound until she returned the trial passed off without the slightest hitch. The engine-room register at the conclusion of the thirty hours' run showed the following results: steam in boilers, 220 pounds; vacuum, 28 inches; revolutions, 66; i. h. p., 3,265; speed, 11.1 knots.

On the 22d of January, 1901, she left port for what is generally considered the most severe test that the engines of a war ship have to undergo, namely, a trial of thirty hours at four-fifths of the maximum horse-power, or 12,000 in this case. The vessel left her anchorage a few minutes before 9 o'clock, and the trial commenced exactly at 10. The course between the Eddystone and Lands End was steamed several times, but shortly after 9 o'clock in the evening it was found that a connecting rod between two cylinders of the port engine had become heated, and the trial had to be discontinued. The sea was not rough, though rather choppy, and an attempt was made to repair the damage, but after considerable time had been spent without success it was decided to abandon the trial, and she returned to the port so that the engine could be overhauled to ascertain the cause of the overheating.

She resumed this trial on February 4, 1901, starting her trial in the most favorable weather at about 9 o'clock on that morning. She met with a gale in the Channel in the evening, and, as she was then in the vicinity of Lands End, felt the full force of the gale, which lifted her stern out of the water, causing the propellers to revolve at a tremendous rate. However, she apparently got over this difficulty all right, and it was not until the morning of the 5th, when in the same vicinity, that some bearings in her port engines again became overheated and steam had to be shut off. It was then found necessary to return to Plymouth, as the character of the defect was such that it could not be remedied by the staff on board. The vessel, with only her port propeller working, arrived at Plymouth about 5 o'clock on February 5, 1901.

On the 13th of February, 1901, she made a third attempt at her thirty hours' trial, and again failed. She left port shortly before 9 o'clock on that morning, and after five hours' steaming the engineers had trouble with the low-pressure cylinder of her port engine, a connecting rod again becoming overheated. She put back to Plymouth and anchored in Cawsand Bay, so that her arrival was unknown, and nobody landed. The defect was not very serious and was put right before daylight.

The vessel left her anchorage at Cawsand Bay at 6:45 the next morning, and, the cylinder having been again tested, it was thought the trial might be successfully run. Steam was got up and pressure put on as gradually as possible, until the 12,000 horse-power was reached. The ship went round the Eddystone and then toward Lands End. All went well until about noon, when the large pin of the low-pressure cylinder, the same that had given the trouble on the three previous occasions, became heated. Firemen and contractors' men went into the engine room, and for more than an hour poured water and oil on the rod. Their efforts were of no avail, and the continued exertions of the whole party failed to keep the rod cool, and the effort had to be abandoned. It was not until the rubbing of the rod had so affected the cylinder and heated the adjoining machinery as to render further running at that high rate dangerous that the order was given to slacken speed. The naval authorities on board were conferred with, and it was decided to have the cylinder overhauled and the pin withdrawn. So she returned to port and had her low-pressure cylinder and the piston rod and connecting pin which caused the trouble lifted out.

Repairs having been made to the engines, on March 12–13, 1901, she had a thirty hours' trial at 12,000 i. h. p., which proved successful.

The following were the mean results: steam in boilers, 260 pounds; steam at engines, 233 pounds; vacuum, 28.1 inches; revolutions, starboard, 100.8, port, 99.3; pressure in cylinders, high-pressure, starboard, 89.35 pounds, port 92.3 pounds; intermediate, starboard, 36.3, port 34.6; low, starboard, 14.8, port, 16.1; i. h. p., high-pressure cylinder, starboard, 1,811, port, 1,840; intermediate, starboard, 1,968, port, 1,844; low, starboard, 2,123, port, 2,271; total, starboard, 5,902, port, 5,955; gross total, 11,857; coal consumption, 1.65 pounds per horse-power-hour; speed, 16.75 knots.

The speed trials were concluded on March 16, 1901, with a most successful run of eight hours at full power over the deep-sea course between Rame Head and Dodman Point. The ship left Plymouth Sound about 8 o'clock on that morning, and two hours later her engines were working at 15,000 horse-power, and the trial commenced. She returned to the sound shortly after 7 o'clock in the evening, the results being satisfactory. With the gross total indicated horse-power of her engines at 15,244, she kept up a continuous speed of 18.22 knots, representing an excess of 0.22 knots over her designed speed; while her coal consumption was reckoned at 1.88 pounds per horse-power-hour. The mean details were: steam in boilers, starboard and port, 270 pounds; steam at engines, starboard, 243 pounds, port, 242 pounds; vacuum, starboard and port, 27 inches; revolutions, starboard, 109.1 per minute, port, 108; pressure at cylinders, high, starboard, 101.8, port, 104.8; intermediate, starboard, 43.7, port, 39.5; low, starboard, 18.7, port, 19.4; i. h. p., high-pressure cylinder, starboard, 2,230, port, 2,273; intermediate, starboard, 2,552, port, 2,289; low, starboard, 2,914, port 2,986; total, starboard 7,696, port 7,548.

Throughout the trial the engines worked admirably, and the port low-pressure crank pin, which was the cause of the 12,000-horse-power trial having to be abandoned three times, worked as smoothly as the other bearings.

VENGEANCE.

This first-class battleship completed her thirty hours' trial at one-fifth power on June 26, 1901. The draught of water forward and aft was 26 feet; steam in boilers, 254 pounds; vacuum, starboard, 26.8 inches, port, 26.9 inches; revolutions, starboard, 66.11, port, 65.88; collective i. h. p., 2,885; speed, 11.35 knots; coal consumption, 1.69 pounds per horse-power-hour.

About July 1, 1901, she had her thirty hours' trial at four-fifths power. With 102.33 revolutions starboard and 102.12 port she developed 10,387 i. h. p. and made a speed of 17.491 knots. The coal consumption worked out as 1.51 pounds per horse-power-hour.

On July 6, 1901, she completed her trials with an eight hours' full-power trial. The draught of water forward and aft was 26 feet; revolutions, starboard, 110.8, port, 110.5; i. h. p., 13,852; speed, 18.5 knots; coal consumption, 1.72 pounds per horse-power-hour.

MEDITERRANEAN SQUADRON.

Between the 9th and 11th of June, 1900, the Mediterranean Squadron had a long-distance steam trial at four-fifths power, the points between which the trial was run being 6 miles east of Gibraltar to 6 miles north of Cape Figari, Sardinia, a distance of 788 miles.

The results of the trial were:

Name of ship.	Class.	Tonnage.	Coal capacity.		Coal short leaving Gibraltar.	Coal used on trial.	Time occupied on trial.		Average hourly speed.
			Ordinary.	Maximum.					
			Tons.	*Tons.*	*Tons.*	*Tons.*	*H.*	*M.*	*Knots.*
Ocean	Battleship, first class.	12,950	1,000	2,300	110.00	518.00	46	54	16.80
Isis	Protected cruiser, second class.	5,600	550	1,076	65.00	264.00	47	12	16.70
Dido	do	5,600	550	1,076	30.00	303.00	48	30	16.25
Renown	Battleship, first class.	12,350	1,280	1,800	441.00	354.30	49	06	16.03
Venus	Protected cruiser, second class.	5,600	550	1,076	25.00	329.75	49	16	15.99
Cæsar	Battleship, first class.	14,900	900	2,200	121.60	406.30	52	30	15.00
Victorious	do	14,900	900	2,200	809.35	455.30	52	36	14.98
Royal Sovereign	do	14,150	900	1,450	89.00	385.00	54	18	14.51
Royal Oak	do	14,150	900	1,450	95.00	509.50	55	10	14.30
Illustrious	do	14,900	900	2,200	116.00	469.90	55	20	14.25
Ramillies	do	14,150	900	1,450	98.00	337.00	55	22	14.22

ABOUKIR.

This new armored cruiser started for her coal-consumption trial at one-fifth power on April 28, 1901. After she had run for nine hours the trial was stopped because of leaks in the main condensers. Repairs were made at sea and the trial was resumed on May 1 and completed on the 2d. The following are the results of the trial: steam in boilers, 230 pounds; revolutions, starboard, 74, port, 75; i. h. p., 4,591; speed, 14.4 knots; coal consumption, 1.9 pounds per horse-power-hour.

On May 3 she started on a thirty hours' trial at four-fifths power. This was interrupted after five hours by a fog, was resumed later and shortened to twenty-six hours. All of the thirty boilers were in use. The steam pressure was 248 pounds; revolutions, 114.25; i. h. p., 16,274; speed, 20.42 knots; coal consumption, 1.77 pounds per horse-power-hour.

Before starting on her final trial, without replenishing her bunkers, she took in water ballast to restore her draught to 25 feet 9 inches forward and 26 feet 9 inches aft. She went to sea on May 7, 1901, and had her final trial of eight hours' duration. The steam pressure in boilers was 285 pounds; vacuum, starboard, 26.3 inches, port, 26 inches; revolutions, starboard, 123.1, port, 123.3; i. h. p., 21,352; mean air-pressure, 0.27 inches; speed by patent log, 21.604 knots. The coal consumption was 1.84 pounds per horse-power-hour.

CRESSY.

This vessel, the first of the new series of armored cruisers, left Portsmouth on the 23d of November, 1900, for a thirty hours' trial at one-fifth power, and returned to port the next afternoon, the trial having been satisfactory. Drawing 25 feet 9 inches forward and 26 feet 9 inches aft, and with 208 pounds of steam in her boilers, she made 73.8 revolutions starboard and 74.3 revolutions port. The vacuum was 26 inches starboard and 26½ inches port, and the collective indicated horse-power was 4,731. Under these conditions she made a speed of 13.89 knots, with a coal consumption of 1.87 pounds per horse-power-hour.

After coaling she left on the 26th for a thirty hours' trial at four-fifths of her full power. The Start was reached with satisfactory results, but there the ship received the full force of a heavy gale from the southwest, and as she dipped her nose into the sea the propellers were lifted out of the water and the engines raced. This overheated the bearings considerably, and the speed had to be decreased and the trial stopped. The vessel went into Plymouth Sound on the 27th at midday, and, after readjusting the bearings and coaling, she left on the 29th, in the morning, to again run the trial, having only completed seventeen hours of it. This was attended with exceedingly satisfactory results. The *Cressy* developed an average indicated horse-power of 16,800 and accomplished 20.5 knots, making 114 revolutions per minute. The Belleville boilers were worked with natural draft, and when the result is compared with the speed for which the ship is designed (for 21 knots at 21,000 i. h. p.) its satisfactory nature will be at once recognized. During this trial the contractors were successful in working in a progressive speed trial for the Admiralty. The vessel returned to Plymouth Sound on the 30th, and remained there until December 4, when, after coaling, she left for a final trial of eight hours at full power over the 23-mile deep-sea course between Rame Head and Dodman Point. In consequence of a thick fog and bad weather generally this trial was postponed until the next morning. It was reported previously that there was a breakdown on the evening of the 4th, while as a matter of fact the ship was in the Sound nearly all day, and has so far not had any breakdown. Bad weather again prevented the trial being started on the morning of the 5th, but she left later in the day. An hour or so after commencing the run the gale increased in violence, and as there was again danger of the bearings becoming overheated, the trial was stopped. Some bearings had become heated, and this was put right while the ship cruised about all night at 7 knots between Start Point and Eddystone. This continued until 7:30 on the morning of the 6th, when, the sea having moderated, the trial was again commenced. With 122 revolutions an indicated horse-power of 21,200 was developed and a speed of 20.79 knots was maintained. Judged by figures this trial does not appear as satisfactory as the previous one at four-fifths of her power. Both the Admiralty officials and the contractors' representatives were, however, completely satisfied, as it was estimated that if the trial had taken place in fine weather instead of a gale, she would have exceeded the speed for which she was built. On this trial the contractors endeavored to maintain the full-speed run as required by the Admiralty, but were obliged to abandon it in consequence of the weather and to be satisfied with their one full-power trial.

SUTLEJ.

This new armored cruiser left Chatham on April 18, 1901, for an eight hours' preliminary trial and a thirty hours' trial at one-fifth power. As the engines were running well at the end of four hours, the thirty hours' test was commenced at once. With a light wind and smooth sea a very good run was made to Plymouth, where four runs over the measured course from Rame Head to Dodman Point were made, which concluded the trial. The indicated horse-power developed was 4,679, which with 75 revolutions of the engines gave a mean speed of 14.03 knots.

On the 23d she left Plymouth for a thirty hours' trial at four-fifths power, but returned during the day with overheated bearings. Owing to the melting of the soft metal in the brasses of the port intermediate-pressure crankpin, new brasses had to be supplied, and after these were adjusted she went for a four hours' trial on the 27th, when the bearings worked considerably.

On the 29th she went to sea again for the regular trial, and returned next day with a report of highly satisfactory results. During the trial four logged runs were made over the 23-mile course mentioned above. The mean result of the whole trial was that with 16,604 i. h. p. a mean speed of 20.628 knots per hour was maintained. The average results for the four runs were: steam in boilers, 248 pounds; vacuum at engines, 26.3 inches; revolutions, 113.5; coal consumption, 1.9 pounds per horse-power-hour. The mean speed and indicated horse-power averaged the same as for the whole trial.

On May 2, 1901, she had her eight hours' full-power trial. The mean results were: steam in boilers, 280 pounds; steam at engines, 240 pounds; revolutions, 122; air-pressure in fire-room, 0.5 inch; i. h. p., 21,261; speed, 21.77 knots; coal consumption, 2.3 pounds per horse-power-hour.

On May 3, the contractor's series of trials being completed, she made the second of a series of Admiralty progressive steam trials—four runs at 18 knots over the measured course, the four runs at 20 knots having been worked in during the trial at four-fifths power. With indicated horse-power of 9,755 a mean speed of 18.129 knots was made for the four runs. The steam pressure in boilers was 249 pounds; vacuum, 26.7 inches; revolutions of both engines, 97.9.

DIADEM.

A writer in the *Engineer* of August 10, 1900, gives the following method of computing the horse-power of vessels at various speeds, which is of interest. He says:

In the *Engineer* of July 27, 1900, at page 59, a leading article quotes certain trial data for the *Diadem*, interesting in themselves, but also affording an illustration of those principles of which, for long, I have endeavored to give an exposition. I tabulate the data as follows:

H. M. S. Diadem.

Gross developed powers, E.	Observed speeds, V.
	N. miles.
12,791 indicated horse-power	19.3
14,933 indicated horse-power	19.7
15,861 indicated horse-power	19.9
17,188 indicated horse-power	20.6

The article referred to states a deduction. "The true speed of the *Diadem* is probably not far from 18 knots, with 11,000 i. h. p." Which seems to me altogether incorrect, and I assert for 18 knots the requisite horse-power can be shown to be 7,765 and not 11,000, a rather serious difference.

This question tested by its peers—the other speed trials under the like conditions—is under the following règime: Up to 19.8 knots the relation of power and speed is expressed by the formula, $E=1.132\ V\ 10^{.1434\ V}$., and at this speed it cataclysmally changes to the very different one, $E=155.6\ V\ 10^{.0354\ V}$., and as far as the highest speed 20.6 knots, is strictly regulated thereby. This implies the initial constant of the second member being suddenly increased 140 times, while, simultaneously, the transcendental factor $10^{.1434\ V}$. changes to $10^{.0354\ V}$., only about one-fourth of its former value.

Test, H. M. S. Diadem.

Speeds up to 19.8 knots. Working formulas, Log. $E=.0538+\text{Log. }V+.1434\ V$. Calculate values of .1434 V, and of .0354 V, for the following speeds:

	V =	18.0	19.299	19.707	19.8	
Logs.	V =	1.2553	1.2856	1.2946	1.2967	
Log. .1434	=	$\bar{1}.1565$	$\bar{1}.1565$	$\bar{1}.1565$	$\bar{1}.1565$	
Sums	=	.4118	.4421	.4511	.4532	
∴	.1434 V =	2.5810	2.7675	2.8257	2.8392	
Add	Log. V =	1.2553	1.2856	1.2946	1.2967	
Add constant	=	.0538	.0538	.0538	.0588	
Sum, or Log.	E =	3.8901	4.1069	4.1741	4.1897	
∴	E =	7765	12,790	14,933	15,480	By formulas.
	E =	?	12,791	14,933	?	By data.

Speeds over 19.8 knots. Log. $E=2.1920+\text{Log. }V+.0354\ V$.

	V =	19.8	19.985	20.6	
Logs.	V =	1.2967	1.3007	1.3139	
Log. .0354	=	$\bar{2}.5490$	$\bar{2}.5490$	$\bar{2}.5490$	
Sums	=	$\bar{1}.8457$	$\bar{1}.8497$	$\bar{1}.8629$	
∴	.0354 V =	.7010	.7076	.7293	
Logs.	V =	1.2967	1.3007	1.3139	
Add constant	=	2.1920	2.1920	2.1920	
Sum, or Log.	E =	4.1897	4.2003	4.2352	
∴	E =	15,480	15,860	17,188	By formulas.
	E =	?	15,861	17,188	By data.

It will be seen, with very slight alterations on the speeds, such not exceeding limits of errors in the most careful observations, the agreement becomes quite perfect. Thus, instead of speeds 19.3, 19.7, and 19.9 of the data, it is far more likely the true speeds were 19.299, 19.707, and 19.985, as employed in the foregoing calculation. Note, also, either formula gives the same power, 15,480 indicated horse-power, for the speed 19.8 knots.

Had we applied the low-speed formula to the 20.6-knot speed, the power would come out 20,975, i. e., 3,787 horse-power, in excess.

Had we applied the high-speed formula to the 18-knot speed, the power would come out 12,150, i. e., 4,385 horse-power, in excess.

The hypothesis upon which writer of the article deduced his power for 18 knots has given him 11,000, i. e., 3,235 horse-power, in excess.

SPARTIATE.

This first-class protected cruiser of 11,000 tons and 18,000 i. h. p., launched October 27, 1898, had a thirty hours' trial at one-fifth power on November 8–9, 1900. She drew 24 feet 6 inches forward and 26 feet 5 inches aft, and had 215 pounds of steam to the square inch in her boilers. The vacuum was 26.9 inches starboard, and 27 inches port, and the revolutions were 69 starboard, and 70.5 port. The total indicated horse-power was 3,834, and the mean speed of the trial was 12.3 knots. The coal consumption worked out at 1.83 pounds per horse-power-hour. After leaving Portsmouth on the 8th, the vessel proceeded eastward as far as Dungeness, and then turned westward. After passing Portland she encountered the full force of the gale, and so severe was the head wind that for a considerable distance the speed was brought down to 9½ knots, though there was no diminution in the horse-power. On passing Plymouth, the ship again turned eastward, and finished her trial at Spithead on the night of the 9th. She used only ten out of thirty Belleville boilers, which gave no trouble of any kind.

On November 13 she started on a thirty hours' run at four-fifths power, but returned on the next day, the trial having proved unsuccessful.

She had been running for four hours when the bearings became overheated, first one and then another, with such rapidity that they were almost simultaneous. It was then found that the white metal in four bearings and one Plummer block was fused and running, and it was at once determined to stop the trial. The ship returned to Spithead at 90 revolutions and 16 knots, at which speed the bearings cooled down and gave no further trouble, but it was not considered desirable to resume the trial. It is said that the trouble was due to her being run into shoal water when turning. The engineers were not told, and sucked water up to flush some of the bearings. There was sand in the water and the bearings were heated to the fusing point by sand friction. She has not yet resumed her trials.

MINERVA.

This protected cruiser, of 5,600 tons, has been put through a series of trials for the benefit of a board which has been investigating the subject of boilers with a view to comparing the coal consumption of the old style of boilers with that of water-tube boilers.

On March 8, 1901, she started for a twenty-four hours' coal and water consumption trial at 5,000 i. h. p. for the information of the boiler committee, and returned to Portsmouth the following day after a successful run. She drew 19 feet 2 inches forward and 23 feet 2 inches aft, and had 144 pounds of steam in her boilers, which are of the cylindrical pattern. The vacuum was 26.75 inches starboard and 26 inches port, and the revolutions 111. The actual i. h. p. was 5,148 and the speed 16.3 knots. The coal consumption was 1.74 pounds per horse-power-hour and the water consumption for all purposes was 15.44 pounds.

PANDORA.

This cruiser, which was built and engined at Portsmouth dockyard, completed, on December 15, 1900, a thirty hours' trial at half power.

She developed 1,789 i. h. p. starboard and 1,849 port, or a collective i. h. p. of 3,638, and with 196 revolutions starboard and 194.4 port she averaged a speed of 16.7 knots, with a coal consumption of 2.11 pounds per horse-power-hour.

She maintained a speed of 16.75 knots very comfortably, but her coal consumption was somewhat high, though, as a matter of fact, she only consumed 3.5 tons per hour while running at 16.75 knots. At the same time, if 2 pounds be the criterion of economy, the *Pandora* in burning 2.11 pounds is not an economical ship.

She started on the 9th of January, 1901, for an eight hours' run with natural draft, but before she had been running long the metallic packing became overheated and the trial had to be abandoned.

Later, on her full-power natural-draft trial trip, which, owing to a fog, lasted but seven hours instead of eight, she made a speed of 18.625 knots; coal consumption, 2.34 pounds per horse-power-hour.

On June 4, 1901, she had a four hours' trial at full power, which gave the following results: draught forward, 12 feet; aft, 15 feet 1 inch; steam pressure in boilers, 225 pounds; vacuum, 26.1 inches; revolutions, starboard 248, port 243; air-pressure in fire-rooms, 2 inches; i. h. p., 7,330; speed, 19.72 knots; coal consumption, 2.5 pounds per horse-power-hour.

MUTINE.

This new sloop-of-war early in February, 1901, successfully completed her thirty hours' steam trials at three-fourteenths and five-sevenths power, and her eight hours' full-power natural-draft trial, the particulars being as follows:

Trial at three-fourteenths power: draught of water, forward, 10 feet 2 inches; aft, 13 feet; pressure of steam in boilers, 170.2 pounds; pressure of steam in engine room, 168.4 pounds; vacuum, 27.15 inches; revolutions, 122.1 per minute; mean pressure, high, 34.63; intermediate, 10.25; low, 6.59; i. h. p., high, 110.2; intermediate, 84.1; low, 135.5; total, 329.8; speed, 8.1 knots; coal consumption, 1.87 pounds per horse-power-hour.

Trial at five-sevenths power: draught of water, forward, 10 feet 1 inch; aft, 12 feet 11 inches; pressure of steam in boilers, 198.7 pounds; pressure of steam in engine room, 195.5 pounds; vacuum, 28.08 inches; revolutions, 181.3 per minute; mean pressure, high, 74.65; intermediate, 24.29; low, 13.27; i. h. p., high, 347.9; intermediate, 291.9; low, 401.1; total, 1,040.9; speed, 12.2 knots; coal consumption, 1.72 pounds per horse-power-hour.

Trial at full power: draught of water, forward, 9 feet 10½ inches; aft, 12 feet 11 inches; pressure of steam in boilers, 225.2 pounds; pressure of steam in engine room, 215.6 pounds; air pressure, 0.17 inches; vacuum, 26.4 inches; revolutions, 206.5 per minute; mean pressure, high, 90.3; intermediate, 31.1; low, 16.67; i. h. p., high, 483.9; intermediate, 428.8; low, 577.9; total, 1,490.6; speed, by patent log, 14.55 knots; speed, on the measured mile, 13.74 knots; coal consumption, 1.63 pounds per horse-power-hour. The trial was satisfactory in every respect, and the horse-power indicated was 90.6 in excess of the contract with Laird Brothers, of Birkenhead, who built and engined the ship. The machinery and Belleville boilers worked satisfactorily throughout.

SHEARWATER.

This vessel, a sister ship to the *Mutine*, completed her steam trials at the beginning of October, 1900, having trials similar to those of the *Mutine*. The particulars are as follows:

Trial at three-fourteenths power: duration, thirty hours; steam in boilers, 163.3 pounds; revolutions, 115.6 per minute; i. h. p., 306.2; speed, 9 knots; coal consumption, 1.88 pounds per horse-power-hour.

Trial at five-sevenths power: duration, thirty hours; steam in boilers, 206.1 pounds; steam at engines, 183.6 pounds; vacuum, 25.65 inches; revolutions, 175.9 per minute; i. h. p., high, 307.6; intermediate, 332.1; low 384.6; total, 1,024.5; speed, 12.85 knots; coal consumption, 1.73 pounds per horse-power-hour.

Trial at full power: duration, eight hours; steam in boilers, 226.8 pounds; steam at engines, 200.8 pounds; vacuum, 23.5 inches; revolutions, 194.2 per minute; mean effective pressure per square inch, high, 85.6 pounds; intermediate, 35.6 pounds; low, 16.6 pounds; i. h. p., high, 430; intermediate, 461.3; low, 541; total, 1,432.3; speed, 13.5 knots; coal consumption, 1.57 pounds per horse-power-hour.

The contract with the Thames Ironworks and Shipbuilding Company, which supplied the machinery, provided for 1,400 i. h. p.

VESTAL.

This vessel, a sister ship of the *Mutine* and *Shearwater*, had her trials during the latter part of August, 1900, of which the particulars are as follows:

Trial at five-sevenths power: duration, 30 hours; steam in boilers, 220.8 pounds; revolutions, 178.5 per minute; i. h. p., 1,014.6; speed, 12.86 knots; coal consumption, 1.42 pounds per horse-power-hour.

Trial at full power, natural draft: duration, 8 hours; steam in boilers, 225.5 pounds; revolutions, 204.8 per minute; i. h. p., 1,484.7; speed, 13.567 knots; coal consumption, 1.55 pounds per horse-power-hour. The specifications called for 1,400 i. h. p. and a speed of 13.25 knots.

Subsequently she had a series of trials to determine coal consumption at various speeds and the consumption of water by her Belleville boilers, of which the particulars are given in the following table:

Power used	$\frac{1}{5}$	$\frac{1}{2}$	* $\frac{1}{2}$	† $\frac{1}{2}$	$\frac{5}{7}$	Full.
Duration in hours	6	30	60	60	30	8
Draught:						
Forward			10′ 4″	10′ 4½″		
Aft			13′	13′		
Steam:						
In boilers ... pounds	183.8	205.2	205.6	207.8	226.3	221.0
At engines ... do	157.5	173.5	183.6	184.8	199.1	191.5
Vacuum ... inches	28.6	27.5	27.46	27.62	27.5	27.5
Air pressure ... do						0.27
Revolutions per minute	120.2	161.8	161.3	163.2	180.3	201.0
I. H. P.:						
High	74.3	196.8	198.3	189.6	306.9	385.5
Intermediate	98.3	251.6	256.6	256.4	343.2	432.4
Low	126.8	279.2	291.4	288.9	369.8	633.1
Total	299.4	727.6	746.3	734.9	1,019.9	1,451.0
Coal consumption per horse-power-hour	1.55	1.41	1.82	1.86	1.30	1.56
Water consumption per horse-power-hour		15.53			15.60	16.80
Speed ... knots	9.0	10.0	10.0	11.0	12.9	14.0

*Using hand-picked Welsh coal; all boilers in use.

†Using Welsh coal as supplied for ordinary service.

VICTORIA AND ALBERT.

The new royal yacht, *Victoria and Albert*, has completed her steam trials, and the official results are given in the appended table, which shows that in all respects the expectations have been more than realized. The yacht was designed by Sir William H. White, K. C. B., the director of naval construction, and was built at the Pembroke Dockyard.

Her dimensions are: length, 380 feet; beam, 50 feet; displacement, with 350 tons of coal on board, 4,700 tons. Great importance was attached to her stability, and the stormy weather experienced afforded opportunity of testing it, and on all occasions with satisfactory results.

In each engine there are four cylinders, the parts being balanced on the Yarrow-Schlick-Tweedy system. The high-pressure cylinder is 26.5 inches in diameter, the intermediate, 44.5 inches, and the two low-pressure cylinders, 53 inches, with a stroke of 3 feet 3 inches. The boilers are of the Belleville type, with economizers, and have 26,000 square feet of heating surface and 840 square feet of grate surface. The fire rooms are artificially ventilated, there being no cowls.

The steam trials set by contract required four runs, the first of forty-eight hours' duration, two, of forty-eight hours each, at 7,500 i. h. p., and a fourth, of eight hours, at full power. The results of all four are tabulated.

Results of contract steam trials of the new royal yacht Victoria and Albert.

	48 hours at 5,000 I. H. P.	46 hours at 7,500 I. H. P.	48 hours at 7,500 I. H. P.	8 hours at full power.
Draught of water, forward	18′ 2″	18′ 2½″	18′ 2½″	18′ 2″
Draught of water, aft	20′ 1″	20′	19′ 11½″	20′ 1″
Steam pressure ... pounds	254	268	272	306
Vacuum ... inches	26.9	26.0	25.25	25.25
Revolutions	110.9	128.4	128.4	147.4
Indicated horse-power	5,142	7,625	7,649	11,298
Speed over long course ... knots	16.32	18.33	18.47	20.53
Coal consumption ... pounds	[1]1.94	[1]1.94	[1]1.87	....

[1] For forty hours.

The first trial took place on August 9 to 11, 1900. As the yacht proceeded down the Channel she cleared a rain storm, but the wind increased in violence till at night it reached three-fourths of a gale. At this time the yacht was steaming between the Lizard and Scilly Islands to avoid the ordinary mercantile traffic and to be ready at daylight to get on the measured course off the Cornish coast. Twice during the night the course was altered, and the stability of the ship, under trying conditions, was thus fully tested. In running before the wind she was perfectly steady; against the wind, she pitched, but her movements synchronized with the action of the sea; with the wind abeam, she rolled, but even in turning the heel did not exceed 10 degrees, and the time taken in rolling from one side to the other was about the average of a well-found war ship. At no time did she dip her nose into the sea, but the spray was of such volume that the smoke-pipes, for more than half their height, were coated with salt. On the morning of the 10th, with a strong breeze still blowing, the yacht reached the measured course, between Rame Head and Dodman Point, over which she made four runs. She had started with only 12 out of her 18 boilers in use, but during the run on the night of the 9th in the open sea, three additional boilers were lighted up as a precautionary measure, and they continued in use for the remainder of the trial. The exact distance of the course is 23.2 miles, and the mean result of four runs gave the time as 85 minutes 25.25 seconds, or a speed of 16.3 knots. The pressure in the boilers was 256 pounds and at the engines 238 pounds. The vacuum was 27.3 starboard and 26.75 port. The revolutions were 113.71 per minute. The engines and boilers gave as much satisfaction as the hull. With the exception of the capstan and the boat hoists all the machinery is below the water-line and under the immediate supervision of the engineer on watch.

The second trial, which lasted only forty-six hours, owing to fog, was on August 16 to 18, 1900. The weather was more moderate and there was neither pitching nor rolling. Six runs were made over the measured course, the mean speed being 18.3 knots, the maximum with the tide being 19.6 knots.

The third trial was on August 23 to 25, 1900. A heavy sea with ground swell was running in the channel throughout the trial, but it had no effect upon the yacht, which, as on the last occasion, proved a thoroughly trustworthy sea boat. There was no perceptible vibration, and in the saloon it was difficult to realize that she was under way in a heavy sea. The mean results, it will be seen, closely approximated to those on the previous trial at the same power, the difference in indicated horse-power being 24, but the coal consumption was rather better, probably a result of experience, being 1.87 pounds instead of 1.94 pounds as in the two preceding trials. On the previous trial at the same indicated horse-power the speed averaged 18.33 knots. On this trial it was 18.47 knots. With regard to the indicated horse-power it may be said that, although the mean result is given, there was very little variation from start to finish.

The full-power trial was on August 29, 1900, and it was in fine weather. The yacht drew 18 feet 2 inches forward and 20 feet 1 inch aft. The steam pressure at the boilers was 306 pounds. The vacuum was 25.2 inches starboard and 26.3 port; revolutions, 147.2 starboard and 147.6 port. The indicated horse-power was 5,620 starboard and 5,678 port, the collective indicated horse-power being 11,298. The mean air-pressure was 0.6 inch, and the mean of four runs over the measured course gave a speed of 20.53 knots. This being a full-power trial, the coal consumption was not taken. On August 30 the yacht had her turning, stopping, starting, and anchor trials.

Any doubts entertained as to stability were entirely dissipated by the behavior of the yacht in two gales, when her speed did not fall off to an appreciable degree, while in a moderate breeze she was perfectly steady. Whether she had to steam through a heavy sea or smooth water the bow wave was clean and regular, with a fine run from the stem to the midship section, and no volumes of water of weight were thrown off from any part; nor was there any churning or thumping under the quarter, whether the ship was traveling at her highest speed or running through a gale. Each trial also disclosed an absence of vibration over the propellers, while the tests that were made in the worst weather she encountered showed that the angle of heel in rolling did not exceed 8 or 10 degrees. The hull and engines thus answered all the requirements of the designers.

BULLFINCH.

This torpedo-boat destroyer, built and engined by Earle's Shipbuilding Company, Hull, had her first official trial at Portsmouth, September 21, 1900, since the disastrous trial that took place on July 21, 1899, when, owing to an accident to the machinery, 11 lives were lost. At the trial the machinery worked satisfactorily. It was stipulated that she was to steam at 30 knots with a coal consumption not exceeding 2½ pounds per unit per hour, but the consumption has not been reported. With 6,022 i. h. p., 225 pounds of steam in boilers, and 394 revolutions the mean speed of the three hours was 29.46 knots.

DOVE.

This torpedo-boat destroyer made, on July 19, 1900, a trial of three hours, under forced draft, with an air pressure of 3½ inches and 390 revolutions per minute she developed 5,848 i. h. p., and made 29.568 knots per hour. She should have developed 6,000 i. h. p. and made 30 knots.

On the 20th of September she had another speed trial, when she developed 6,012 i. h. p. with 225 pounds of steam in boilers, and averaged 391 revolutions. The recorded speed was 29.263 knots.

After other unsuccessful attempts to make 30 knots speed she was sent out on April 23, 1901, for a 29-knot trial. She was required to maintain 388 revolutions, which were calculated to give her the required speed, but she averaged only 386 revolutions.

EXPRESS.

This torpedo-boat destroyer had her steam trials on the Clyde during the latter part of May, 1901. She had six runs over the measured mile course and maintained a speed of 30.9 knots, the engines developing 9,250 i. h. p. The contract speed required to be made is 33 knots. She had other unsuccessful trials, and during the last week in June, 1901, she resumed her trials for the fourth time, and for the fourth time the trials had to be abandoned, owing to the machinery breaking down. For three hours the engines worked splendidly, but the required speed of 33 knots could not be attained. Just as the trial was about to terminate a portion of the intermediate cylinder was fractured.

FALCON.

This torpedo-boat destroyer had her trials in October, 1900. Mean results: speed trial, 30.135 knots; coal-consumption trial, 30.09 knots.

FERRET.

This torpedo-boat destroyer had her steam trial in July, 1900, off Plymouth, averaging 24 knots speed.

KANGAROO.

This torpedo-boat destroyer, built by Palmer's Shipbuilding Company, Jarrow-on-Tyne, had a satisfactory three hours' coal-consumption trial at Portsmouth on March 13, 1901. She developed 6.477 i. h. p., which gave her 379.85 revolutions, and the speed was 30.184 knots. The air pressure was 2.8 inches. During the three hours she made six runs over the measured mile in Stokes Bay, when the speed, with 6,507 i. h. p. and 2.6 inches of air pressure, was 30.031 knots.

She had a second full-power trial at Portsmouth March 19, 1901. The cone was hoisted at the dockyard semaphore to indicate a northerly gale, and as the day advanced the wind increased in violence, so that when open water was reached the vessel was washed fore-and-aft, while seas broke over her fore-bridge, where the deck officers were stationed. At her first official trial, which was to ascertain her coal consumption at full power, she burned 2.24 pounds per unit of power per hour, and this entitled her to a reduction of 4 tons in the load she carried on this trial. As a matter of fact, she was lightened only 3 tons, but the advantage was entirely neutralized by the gale, which decreased her speed by a third of a knot. The mean speed for the three hours was 30.03, and the revolutions were 378.8; the i. h. p. was 6,463. These figures did not materially differ from the records taken on the six runs over the measured mile which formed part of the three hours' run. During this part of the trial the speed was 30.073, the revolutions were 385.15, the i. h. p. was 6,510, and the air pressure in fire-rooms throughout was 2.7 inches. It was the severest weather ever experienced at Portsmouth by a 30-knot torpedo-boat destroyer running a successful trial.

LEE.

This torpedo-boat destroyer underwent a successful three hours' coal-consumption trial on November 21, 1900. On the six runs over the measured mile her average speed was 29.9 knots, but for the whole of the three hours the speed was 30.11 knots. The official results were as follows: draught of water forward, 5 feet 4.5 inches, aft 8 feet 10.75 inches; steam in boilers, 249 pounds per square inch; vacuum starboard 23.3, port 23.1; revolutions per minute, starboard 380.7, port 380.4; mean i. h. p., starboard 3,382, port 3,193, total 6,575.

LIVELY.

This torpedo-boat destroyer, built by Laird Brothers at Birkenhead, had a successful full-power coal-consumption trial on the Clyde, March 15, 1901. The following results were obtained on six runs over the Skelmorlie mile:

Number of run.	Steam pressure.	Time on miles.		Revolutions.		Speed.	I. H. P.
				Starboard.	Port.		
		min.	*sec.*				
1	220	2	1	386.8	390.2	29.752	6,061
2	230	1	59⅖	200.0	402.6	30.152	6,501
3	223	1	58⅗	395.6	396.2	30.354	6,371
4	250	2	0⅕	395.5	397.7	29.950	6,323
5	228	1	57⅖	398.7	400.7	30.664	6,465
6	226	2	0⅗	395.0	396.0	29.850	6,396

The mean speed for the three hours was 30.278 knots.

On March 27, 1901, she made a continuous run of twelve hours for the purpose of testing her coal consumption. The engines were run with 415 i. h. p., maintaining a speed of 13 knots with a consumption of 2.25 pounds per horse-power-hour.

MYRMIDON.

This torpedo-boat destroyer had a very successful trial of speed in February, 1901. With 6,623 i. h. p. and 379.4 revolutions she averaged a speed of 30.134 knots. The air pressure in the fire-rooms was 2.97 inches and the coal consumption 2.196 pounds per horse-power-hour. This being 0.3 pound under the standard consumption allowed by the Admiralty, she was entitled to carry 6 tons less than her normal load, but as the speed trials had to be followed by the stopping, starting, and turning trials the contractors availed themselves of but half the allowance.

With 6,303 i. h. p. and 377.2 revolutions the mean speed for three hours was 30.229 knots with an air pressure of but 2.7 inches. Immediately afterwards a run over the measured mile with wind and tide favorable showed a speed of 32.086 knots while the mean of six runs over the mile gave a speed of 30.524 knots per hour.

OSTRICH.

This torpedo-boat destroyer had her official trials in October, 1900. The mean results were: speed trials, 30.113 knots; consumption trial, 30.161 knots. She also made a special coal consumption trial at low speed (11 knots) and low power, running a distance of about 44 miles per ton of coal.

SHARK.

This torpedo-boat destroyer had her full speed trial off Plymouth in July, 1900, averaging 28.5 knots.

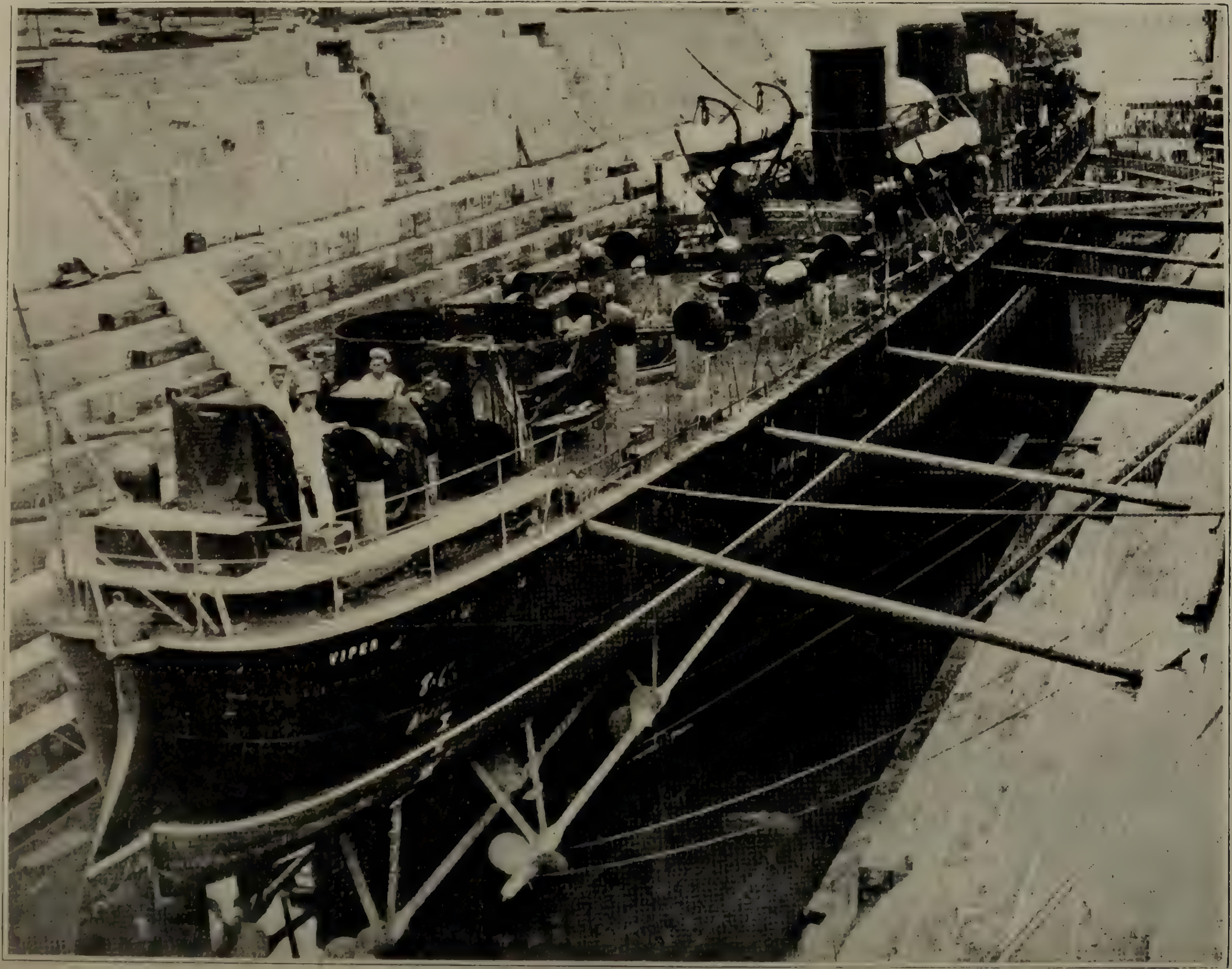
SPRIGHTLY.

This torpedo-boat destroyer carried out her official full-power coal-consumption trial at 30 knots on May 22, 1901, with successful results. She obtained 30.2 knots as the mean of six runs over the measured mile, the speed for three hours continuous steaming being 30.03 knots.

VIPER.

This torpedo-boat destroyer, the first vessel to be engined on the turbine principle, has had several trials during the past year both for speed and for coal consumption.

In appearance she does not differ materially from the 30-knot destroyer now generally adopted, except that her smoke-pipes are of much greater diameter, while in dimensions, displacement, and deck fittings she presents no features of novelty.



VIPER. ENGLISH TORPEDO-BOAT DESTROYER, 325 TONS.

The following are the details of the one hour full-power trial on the 13th of July, 1900, off the mouth of the Tyne:

When the vessel left the jetty, at 11:10 a. m., the displacement was 380 tons, the load carried being about 10 tons in excess of the Admiralty requirements for 30-knot destroyers. She steamed down the Tyne at 14 knots speed to Tynemouth Pier, which was passed at 11:45, and at 12:05 she passed the mile post at a speed of 36.585 knots. She had, therefore, worked up from a speed of 14 knots to 36.585 knots in twenty minutes.

The six consecutive runs were at the following speeds:

	1.	2.	3.	4.	5.	6.
Time on measured mile (in minutes and seconds)	1:38⅖	1:41⅖	1:37	1:38⅖	1:37	1:39⅘
Equivalent speed (in knots)	36.585	35.503	37.113	36.585	37.113	36.072

The mean of two runs with and against the tide was 36.849 knots. The Admiralty mean of the six runs over the mile, with and against the tide, was 36.581 knots, which speed was also the mean for the hour's run. The mean revolutions for the hour's run were 1,180 per minute. The steam pressure in the turbines ran up to 200 pounds per square inch and the mean air-pressure in stokeholds was 4½ inches. The unusually short time required for working up to full speed was as remarkable a feature of the trial as the extremely high speed recorded, both features being considered very valuable in war vessels. Throughout the trial the machinery worked with the utmost smoothness, and practically no vibration was experienced in any part of the vessel.

Early in August, 1900, she ran at 31.118 knots for three hours, and the coal consumption was 2.38 pounds per horse-power-hour.

On the 31st of August, 1900, she had a coal-consumption trial of three hours' duration. She maintained a mean speed of 33.8 knots per hour with a consumption of 11 tons 9 hundredweight of coal per hour. The engines developed 10,300 i. h. p., whence it appears that she consumed 2.49 pounds per unit of power per hour, or a fraction less than 2.50 pounds, which is the maximum full-power consumption allowed for destroyers.

The question whether she is economical in coal consumption has been the subject of much discussion. A 30-knot destroyer at 6,000 horse-power burns 2½ pounds per horse-power-hour. The *Viper* at 10,000 horse-power burns also 2½ pounds per unit, but she gives a speed of 34 knots. The ratio is, therefore, equal; but while on the one hand the *Viper* could with her 34 knots overreach her 30-knot opponent, and with her steady gun platform destroy her, she obviously on the other hand can not keep the sea for many hours when she is burning 11½ tons of coal per hour. Again, at her economical speed the *Viper* consumes 25 hundredweight per hour, against 15 hundredweight, which is the normal consumption of the 30-knot destroyers.

Mr. Charles A. Parsons, the managing director of the Turbinia Works, at Wallsend-on-Tyne, writes as follows with regard to the trials of the *Viper:*

> The recent trials of the *Viper*, which is the first torpedo-boat destroyer to be fitted with steam-turbine propelling machinery, have attracted much attention, and as the results have proved entirely successful, the specified speed being greatly exceeded, and all previous records (including those of the *Turbinia*) have been broken, perhaps I may be allowed to discuss certain points in connection with the figures attained which are of considerable interest and importance.
>
> We had not ourselves thought of making a strict comparison between the coal consumption of the *Viper* at any particular speed with that of other vessels of similar tonnage, as she differs in essential particulars from all other vessels, and such a comparison would be entirely misleading unless accompanied by a full statement of the principal features of the vessels to be compared, with their necessary bearing upon the results. But as other persons have thought well to make an unqualified comparison, I now propose to briefly place the case on a sound footing, and I may add that the comparison is interesting and instructive, especially to those whose business it is to design or to use fast vessels. The trials of the *Viper* have been somewhat more elaborate than usual for torpedo-boat destroyers, though they do not as yet by any means cover the whole of the ground. They have included a coal-consumption trial at the contracted speed of 31 knots, the mean speed during the three hours being 31.118 knots, and the coal consumption, as determined from the usual hull-resistance experiments, 2.38 pounds per horse-power-hour, the contract being not to exceed 2.5 pounds per horse-power-hour. The power required for this speed is about two-thirds of the maximum for which the engines and boilers were designed, the maximum being upward of 12,300 i. h. p., which power has been realized on the preliminary, but official, full-power contractor's trials, the maximum mean speed then reached being 36.858 knots.
>
> The second official trial was a three-hours' coal-consumption trial with air pressure limited to 3½ inches, and carrying the full weights as determined by the previous trial, under the usual Admiralty conditions. A mean speed of 33.838 knots was maintained with about four-fifths of the maximum power, the coal consumption being at the rate of 2.49 pounds per horse-power-hour.
>
> The third official trial was the usual twelve hours' coal-consumption trial at cruising speed. In recent years the stipulated speed on this trial has been increased from 13 to 15 knots (this I mention, as the coal consumption of the *Viper* at 13 knots is only about two-thirds that at 15 knots). The ascertained coal consumption of the *Viper* on this trial was at the mean rate of 27 hundredweight per hour. It should be mentioned, however, that H. M. S. *Cobra*, the second fastest ship afloat, with the same size turbine engines and similar in every respect to the *Viper*, but loaded to the service conditions, and having a displacement of 442 tons, or about 60 tons greater than the *Viper*, consumed on her official 15-knot trial only 24.58 hundredweight per hour. In her case the port engines only were used, the starboard engines being dragged round by the propellers, and it is probable that the *Viper* with her less displacement would, when using one set of engines only, burn less coal than the *Cobra*. As, however, it would be instructive to ascertain the result definitely, it is probable that the test will be made at an early date.
>
> Now to the case in point. A comparison has been made of the coal consumption of the *Viper* and the *Albatross* at a speed of about 31 knots. It so happens that the vessels have the same displacement, and it is tacitly assumed in the accounts that

the horse-power necessary to drive the two vessels is the same, which is by no means the case, for the following reasons: in the case of the *Viper*, all the underwater fittings, such as the rudder, the shafts and brackets for carrying the propeller blades and bosses, etc., have all been designed to stand the highest speed of over 36 knots, and are of considerably larger and heavier scantlings than usual, and in consequence offer increased resistance to their passage through water. So much for the shipbuilder's point of view.

Now for the engineer's side of the question. To give to the *Viper* her 5 extra knots, and to usefully absorb the relatively enormous horse-power developed by her engines, her propellers have extra width of blade and a much greater total blade area than those of the *Albatross*, whose maximum horse-power is only about two-thirds of the *Viper's*. This greater blade area is not only useless at lower speeds, but involves a positive waste of power at such speeds, owing to the increased skin friction. If, on the other hand, the *Viper's* propellers had been designed for a maximum speed of only 32 knots (the contract speed of the *Albatross*), they would undoubtedly give superior results at about 31 knots.

Then, as regards the turbine engines themselves: at the speed of 31 knots the *Viper's* engines are working at only two-thirds full power, and are necessarily less economical than if they had been smaller and designed for the power required for 32 knots.

Then, there are the boilers to compare, a very important item in the case. The *Viper* has the well-known Yarrow boilers, of simple construction and of great durability and power, but is without any refinements external to the boiler for attaining the highest possible economy of coal—refinements, be it said, of somewhat doubtful advantage in ordinary service. The *Albatross*, on the other hand, has the equally well-known Thornycroft boilers; she has also feed-water heaters to increase the efficiency, and also compressed-air jets for promoting more complete combustion of the furnace gases before coming in contact with the tubes.

These are now the factors of chief importance bearing upon the question of the relative coal consumption of the turbine engines and the reciprocating engines in the respective vessels. On the other hand, we have the larger engines, greater propeller-blade area, heavier under-water fittings, greater hull resistance, powerful, durable boilers of simple construction without external adjuncts for attaining the highest economy on trial, the vessel being capable of maintaining a speed of 5 knots in excess of any vessel propelled by reciprocating engines. On the other hand, we have a vessel whose engines and propellers are capable of developing only about two-thirds of the horse-power of the other, designed for a much lower speed, in fact about that at which the comparison is taken, and having boilers of noted efficiency in coal, assisted by somewhat complex additions for further increasing the economy.

That the reduction in the coal consumption attributable to the aggregate of these differences greatly exceeds the difference between the coal consumption of the *Viper* and *Albatross* at about 31 knots' speed there can be no question whatever, and there can not be the slightest doubt that in every class of vessel (excepting very small or slow vessels) it will be found that the turbine system of propulsion will give superior results over the reciprocating engine as regards coal consumption.

In the *Viper*, in spite of these losses of power at lower speeds which have been described and incurred in order to reach the record speeds attained (speeds only attainable by turbine machinery), without any special effort to attain economy—even so, her coal consumption per horse-power realized is very little in excess of the best, and less than that of many of the 30-knot destroyers. In the specifications of most Admiralties for torpedo-boats and destroyers the question of speed is placed in the fore part, and enforced under heavy penalties, culminating with the option of complete rejection of vessels should the deficit reach more than 2 or 3 knots below that contracted for. The coal consumption is relatively placed in the background.

This being so, the designers of the *Viper* may be pardoned if they have made every effort to attain the highest possible speed and have not given sufficient consideration to the question of obtaining the utmost economy of fuel of which turbines are capable; but in this, their first destroyer, they can at least claim to have beaten all records of speed by a long interval, and in their future ships they will be able to show by how much they can beat all records as to economy in coal.

VIXEN.

This torpedo-boat destroyer completed her steam trials on the Clyde with a twelve hours' continuous run on March 27, 1901, to test her coal consumption. With 500 i. h. p. she maintained a speed of 13 knots with a consumption of 1.8 pounds per horse-power-hour.

NO. 99.

This torpedo boat of 150 tons ran a satisfactory full-speed trial at the Maplin Sands on May 29, 1901. The speed attained was 25.069 knots during a three hours' run, carrying a load of 42 tons.

FRANCE.

HOCHE.

This old battleship having been reconstructed, which has had the effect of reducing her draught and increasing her freeboard through reducing her superstructure and total weight of armament, has been subjected to several trials which were considered satisfactory. On August 1, 1900, a coal-consumption trial of six hours gave the following results: 7,340 i. h. p. and 10.3 knots speed. Coal consumption per square foot of grate per hour, 20.5 pounds; per horse-power-hour, 2.49 pounds.

On August 21, on a full-power trial, she developed 10,809 i. h. p., with 86.3 revolutions per minute and a speed of 16 knots. Coal consumption, 2.36 pounds per horse-power-hour.

JÉNA.

This new ship went to sea on the 19th of January, 1901, to undergo trials at medium speed on the base of St. Mathieu to Trigana. All the apparatus worked well. The engines developed 5,100 i. h. p., and with 90 revolutions the mean speed was 14 knots—a very good steaming speed, and easily obtained with a relatively moderate horsepower.

On the 12th of February, 1901, she had a preliminary trial off Brest. After a run of four hours at 12,500 i. h. p. the engines were speeded up to 120 revolutions, which it was deemed would be about the maximum for full power. The engines developed 15,000 i. h. p., and a speed of 17 knots was attained. The coal consumption was 1.67 pounds per horse-power-hour.

On March 26, 1901, she had an official trial of six hours' duration.

Steam was carried in 14 of the 20 boilers, and she developed 5,581 i. h. p., and maintained a speed of 13.8 knots with a coal consumption of 1.37 pounds of coal per horse-power-hour. The consumption provided for in the contract was 1.43 to 1.54 pounds. The trial was in all respects satisfactory.

On April 2, 1901, she had another trial of six hours' duration, in which all of the 20 boilers were in use. She developed 12,500 i. h. p., and maintained a speed of 17.4 knots with a coal consumption of 1.51 pounds per horse-power-hour.

About April 25, 1901, she had a satisfactory trial of twenty-four hours' duration. The engines and boilers worked well, without any incidents, and developed 9,830 i. h. p., giving a continued speed of 16.3 knots with a coal consumption of 1.79 pounds per horse-power-hour.

CHATEAURENAULT.

This first-class protected cruiser made, about July 20, 1900, a twenty-four-hour trial, during which, with 14,000 i. h. p. and 108 revolutions per minute, she attained a speed of 21 knots. The consumption of coal was 1.497 pounds per horse-power-hour. These results surpassed anything that had been attained up to that time. When it is considered that she is able to exert 23,000 i. h. p. it can be easily seen that she should readily attain a speed of 24 knots. The small consumption of coal at the moderate power of 14,000 assures for the vessel a remarkable radius of action.

On August 8, 1900, she went out for another trial, and for twenty hours she developed 14,400 i. h. p., and, with 111 revolutions, made a mean speed of 21 knots. Then for two hours she developed 18,000 i. h. p., and, with 120 revolutions, made a speed of 22.697 knots.

According to the contract the coal consumption was not to exceed 1.76 pounds per horse-power-hour at 13,800 i. h. p., but this figure was not reached at 18,000 i. h. p. At this power she only burned 1.54 pounds per horse-power-hour, while at 14,400 i. h. p. she burned 1.48 pounds.

It appears that the lack of success in the trials of this vessel and the time spent in preparing for the full-power trial are due to the imperfect alignment of the engines. It is hoped to complete the trials in July. The boilers of the vessel are able to supply, without forced draft, more steam than can be used when the engines are working at their maximum power.

ÉPÉE.

This torpedo-boat destroyer, in February, 1901, had a series of trials which were considered satisfactory. With 262 revolutions she made 22.35 knots; with 277 revolutions, 24.21, and with 282 revolutions, 24.88 knots. The last trial at full power was not all that could have been desired, so it was decided to change the screws in order to attain greater speed. In April, 1901, with 301 revolutions, she made 25.62 knots.

ESPIGNOLE.

This torpedo-boat destroyer completed her trials in September, 1900. She attained a mean speed of 27.25 knots with 300 revolutions, which was considered satisfactory. In August, 1900, she had a satisfactory coal-consumption trial. At the speed of 14 knots she consumed 56.2 pounds per mile.

PIQUE.

This torpedo-boat destroyer made, on September 17, 1900, two sets of trials, the first at 22 knots, the second at full power. The last, having given a speed of 24.88 knots with 288 revolutions, was declared unsatisfactory, and the screws were ordered modified before a new trial. The engines and boilers worked well.

Trials in January, 1901, failed because the heat melted the grate bars in the furnaces. On February 1, 1901, she had satisfactory preliminary trials at full power, making a mean speed of 25.887 knots with 300.4 revolutions.

On March 13, 1901, she had satisfactory trials of speed. The results were: revolutions, 247; speed, 20.7 knots; revolutions, 297.8; speed, 25.5 knots.

YATAGHAN.

This torpedo-boat destroyer finished her trials in July, 1900, making a mean speed of 26.96 knots, or 1 knot in excess of contract speed, which gives the builders a bonus of $5,500.

AUDACIEUX.

This sea-going torpedo boat had a trial in January, 1901, and exceeded 25 knots, but did not make the required 26 on account of being somewhat foul on her bottom. In February, 1901, on a two-hours' trial at full speed, she maintained a speed of 26.2 knots, or 0.2 knots above the contract.

BORÉE.

This sea-going torpedo boat had a satisfactory trial April 2, 1901, the speed attained being 29.02 knots.

LANCE.

This torpedo boat had a trial in February, 1901. Mean speed, 14.5; i. h. p., 950. The condensers did not give satisfaction.

SALVE.

This torpedo boat had a trial in February, 1901, which was satisfactory. The mean speed for two hours was 15 knots; i. h. p., 1,000.

"147."

Torpedo boat No. 147 had satisfactory trials in May, 1901. With 316 revolutions she made a speed of 22.7 knots.

"240" AND "246."

The full-speed trials of these torpedo boats in January, 1901, were satisfactory. They attained speeds of 25 knots and 25.3 knots, respectively.

MORSE AND NARVAL.

M. de Lanessan, Minister of Marine, and General André, Minister of War, visited Cherbourg on the 6th of January, 1901, to witness comparative trials between the submarine vessels *Morse* and *Narval*, with a view to determining the relative merits of the two systems for guidance in the construction of the new submarine vessels provided in the program for 1901. The ministers were conducted at once to the quay, where are situated the conductors which charge the accumulators used in the submarine boats. The crews of the two vessels were there drawn up for inspection, and were seen to be seamen wearing the ordinary uniform with the addition of a red cap ribbon bearing the words *Sous-Marins.*

The *Morse* is a submarine boat proper. The *Narval* is a boat of the submersible type, which under ordinary circumstances navigates on the surface as a torpedo boat, but can be submerged, becoming then a submarine boat. In the first case the motive power is a petroleum engine; in the second, electricity supplied from accumulators.

The *Morse* has a displacement of 146 tons, and is cylindrical in shape, with a length of 36 meters (118 feet) and diameter of 2.70 meters (8 feet 3 inches). The forward end is fitted with a torpedo discharging-tube, and at the after end is the propeller. From the tube to the motor extends a long passage, having at the sides two rows of accumulators superimposed. In the center, under the captain's conning tower, which is reached by an iron ladder, are all the levers and handles for working the machinery which moves the boat both in a vertical and horizontal direction. Above are two manholes, one communicating outside with a narrow platform of latticework raised about 30 centimeters (11 inches) above the hull of the vessel and under which the water is free to pass; the other with the conning tower, which itself has also a manhole communicating with the outer air, besides three small glass scuttles, all of which can be hermetically closed from the inside. Under the horizontal deck, which extends almost from end to end, are ballast tanks, which can be filled at will with water when it is desired to submerge the vessel. From the conning tower the captain directs the vessel when navigating on the surface. When submerged she is guided by means of the periscope, an instrument which projects above the water when the boat is submerged to any depth up to 6 meters (19.6 feet). This ingenious device reflects everything within its field of vision, and can be turned round so as to cover the whole horizon.

When the Minister of War had embarked on board the *Morse*, orders were given to get under way, and she proceeded from the dockyard basin out into the harbor. A considerable sea was running outside, sufficient to make the steam launch which followed behind and in which the Minister of Marine had taken his seat pitch and roll considerably. The *Morse*, however, was wonderfully steady, rolling very slightly only. After crossing the harbor she steered toward the *Impregnable* hulk, which serves as a workshop and quarters for those engaged in adjusting torpedoes. Here she awaited orders to submerge, which were soon after given. The ballast tanks then commenced to fill, and in a few moments the voices of the men in charge were heard reporting "forward tanks full," "after tanks full," "midship tanks full." The manholes were then closed and the *Morse* commenced to sink. The water rose first over the scuttles, and finally over the conning tower, allowing only a bluish light to filter through the glass. The whole operation of submerging does not take more than two minutes to complete, and all that can then be seen of the *Morse* above the surface is the periscope, which, having a diameter of only 10 centimeters (3.9 inches), is quite invisible at a short distance.

The feeling experienced at the moment the vessel is making her descent is most peculiar. It is one of expectancy, but nothing happens. One is astonished at the quiet—the absolute calm. There is no movement; not even a tremble. The waves wash overhead without causing the least vibration. The motor works silently, and the vessel glides through the water without causing any bow wave or leaving any track. Alone the voice of the captain is heard, who, standing by the periscope, gives his orders for so many degrees of helm and so many revolutions of the engine. The little vessel is now almost in equilibrium, and would sink deeper or rise to the surface were it not for the "ailettes" on each side, which serve to prevent this. Before an instrument which indicates the depth stands a petty officer with his eye fixed and his attention concentrated on the pointer, and by turning a wheel he causes the "ailettes" to act so as to maintain the vessel at the required depth. Should she for any reason continue to descend or refuse to ascend, a pig of lead ballast can be detached, which would cause her immediately to rise to the surface; but after this the buoyancy would be so much increased that she could no longer be submerged, even with all the ballast tanks full. Orders had been given to remain a quarter of an hour under water, and at the expiration of the time pumps are set in motion and the water was forced out of the ballast tank and the *Morse* commenced to rise. The conning tower and the small platform emerge, and the manholes are opened. No commotion takes place at the entry of the external air, and no inconvenience has been felt by those on board during the dive, the act of breathing being as free and regular as in the open air. Trials to ascertain the habitability of the *Morse* had already been made, and she has remained for eight hours under water, the crew experiencing no difficulty in breathing and no buzzing sensation in the ears, no excitation or inconvenience of any sort, and it was considered they could have remained double the time if necessary, the chemical analysis of the air showing also that it would have been possible to considerably prolong the trial if required.

The Minister of War, after disembarking from the *Morse*, joined the Minister of Marine on board the *Impregnable*, and the next trial was with the *Narval*. As has already been stated, the *Narval* is a submersible torpedo boat. On the surface she acts like an ordinary torpedo boat, the engines being worked by steam. When submerged she becomes a submarine boat, and the motive power is electricity. She has a displacement of 106 tons, and is not cylindrical like the *Morse*, but her upper works being flat form a deck, and the conning tower, funnel, and periscope project above this, giving her at a distance a novel and peculiar appearance. The submerging of the *Narval* is rather a delicate operation—the motive power has to be changed, the smoke-pipe, etc., have to be drawn in, sufficient time has to be allowed for the unused steam to cool down, and a much greater quantity of water than in the case of the *Morse* has to be introduced into the ballast tanks to overcome her buoyancy. Great progress has been made in these respects since her first trials, and the operation of submerging has been much accelerated, but it still takes considerably longer than in the case of the *Morse*. On the present occasion the submergence was effected in a quarter of an hour, and when submerged the only thing visible above the water was the periscope. The trials were suspended at 11:30 a. m., and the ministers then proceeded to the prefecture for déjeuner. In the afternoon they again went on board the *Impregnable* to witness submarine practice from the submarine boats.

The *Morse* has three firing positions; the bow tube with air impulse, and two special carriers on the side, each holding one torpedo, which, when fired, are simply detached and proceed with their own motive power; all three can fire only in the axis of the vessel. Four shots were fired and in each case the torpedo ran straight and true. The *Narval* has four discharging positions on a system invented by M. Drzewiecki, which allow of the torpedo being fired in any direction. Four shots were also fired, but with not quite so satisfactory results as from the *Morse;* but the day was drawing to a close and the light was bad. The ministers expressed themselves well satisfied with what they had seen, and returned to Paris in the evening.

GERMANY.

HAGEN.

This coast-defense ship having been lengthened 23 feet and otherwise reconstructed, so that she is really a battleship of the third class, has had steam trials which have proved satisfactory, and other vessels of the same class are to have similar changes made to increase their efficiency.

Before the reconstruction, the *Hagen*, with her locomotive boilers, with an air pressure of 1.8 inch, had a maximum efficiency of 4,545 i. h. p., and a speed of 14.85 knots. With her Thornycroft boilers the maximum efficiency, with an air pressure of 0.8 inch, is now 5,250 i. h. p., and the speed, with 5,000 i. h. p., is 15 knots.

FREYA.

This first-class protected cruiser has completed her official trials. In April, 1901, she steamed for five days in succession at 16 knots per hour. Her engines and boilers gave general satisfaction.

VICTORIA LUISE.

This first-class protected cruiser, of 5,650 tons, has disappointed her designers, as her speed, under forced draft, with 10,000 I. H. P., was only 18.5 knots, where 20 knots were calculated. The *Freya* and *Hertha*, sister ships to this one, are also said to be deficient in speed. They all have water-tube boilers of the Dürr type.

NIOBE.

This third-class protected cruiser, of 2,800 tons, had preliminary official trials for the purpose of inuring the engine personnel, July 10–12, 1900. Runs were made at different rates of speed, the last one at full power. Engines and boilers worked faultlessly. The official trials gave the following results:

Speed trials of German cruiser Niobe.

Number of trial	1.[1]	2.	3.	4.	5.
Date of trial	July 9	July 20	July 25	Aug. 1	Aug. 2–5
Duration of trial, hours.	6	24	24	24	72
Draught forward	14 feet 1 inch	14 feet 1 inch	14 feet	14 feet	14 feet 2 inches
Draught aft	17 feet 3 inches	17 feet 4 inches	17 feet 3 inches	17 feet 3 inches	17 feet 4 inches
Indicated horsepower	8,113	926	1,221	3,636	4,921
Revolutions	166.6	79.6	87.25	127.25	140.3
Air pressure under grates, inches.	1.4	....	....	....	0.4
Speed	21.6	11.1	12.0	17.0	19.45
Coal per square foot of grate per hour.	....	14.10	14.89	14.53	20.97
Coal per horse-power-hour.	....	2.42	2.13	1.86	2.01

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[1] This trial made with forced draft.

In trials 1, 4, and 5 all of the eight boilers were in operation. The best speed attained during her first trial was 22 knots.

On August 9 several trips were made on the measured mile. The results of four runs on the mile in Eckernförde Bay are as follows:

Indicated horse-power	8,631	3,554	1,199	958
Revolutions	166.4	126.73	87.09	81.03
Speed .... knots	21.594	17.048	11.979	11.189

The mean draught during these runs was, forward, 14 feet 2 inches; aft, 17 feet 4 inches. Pitch of screws, 16.4 feet.

NYMPHE.

This new "small cruiser," of 2,800 tons, carried out her trials off Kiel in December, 1900. With the engines making 158 revolutions, and developing a little over 9,000 i. h. p., a speed of 22.3 knots was attained, showing a vast improvement over the *Gazelle*, the first ship of the class, whose maximum speed is only 19 knots. This vessel is fitted with the Schultz water-tube boilers, and the estimated speed was to be 21.5 knots.

On January 9, 1901, she began an endurance trial at high speed, which was stopped after seventy-one and one-half hours because of fog. The mean results were as follows: draught forward, 14 feet 10 inches; aft, 16 feet 10 inches; air pressure in fire room, 0.7 inch; revolutions, 143.9; i. h. p., 5,624; speed, 19 knots; coal consumption, 2.08 pounds per horse-power-hour.

TRIAL REQUIREMENTS FOR GERMAN TORPEDO BOATS.

All German torpedo boats have their acceptance trials with a personnel of naval machinists and firemen, under the command of naval officers and engineers, on the open sea—"storm trials" are a special feature included in the requirements—and with complete war equipment in the way of coal supply, boiler feed-water, armament, spare parts, provisions, etc. This means a difference of several knots when comparisons are made with speeds of torpedo boats of other nations. The principal trials required are as follows:

A fourteen-hour coal-consumption trial, at 12 knots speed, with 67 tons of coal on board, in which case the coal consumption is not to exceed 881.85 pounds per hour.

A three-hour forced-draft trial, the torpedo boat being fully equipped and carrying sufficient coal for steaming 2,000 miles at the rate of 12 knots an hour. This run takes place on the open Baltic in calm weather and a smooth sea, with a force of wind of less than 3. The distance steamed on this trip is to be at least 76 miles, which corresponds to a speed of 26 knots an hour.

A twelve-hour coal-consumption trial, at the rate of 15 knots an hour, in which case the coal consumption is not to exceed 1,323 pounds an hour.

A "storm trial" to test the behavior of the torpedo boat at sea. Without detriment to either ship or machinery, the torpedo boat must steam four hours on the open sea, with a number of revolutions corresponding to 15 knots in smooth water, with a force of wind of 7 to 10[1]—at least one of the four hours against wind and sea. During this trip the stability of the torpedo boat and its nautical qualities must prove to be entirely satisfactory under all circumstances.

An engine-maneuvering trial, consisting of a several-hour forced-draft run under constant engine maneuvers, designed to test the maneuvering capabilities of the engines and their stability under sudden changes, as, for instance, from full speed ahead to full speed astern.

The rudder-maneuvering trial, for testing the efficiency and stability of the whole steering gear, with the helm in different positions, and with the engines going ahead as well as astern, to determine the tactical diameter.

Finally, trials are made of the different pumps (steam, bilge, feed, and circulating), the heating and lighting installations, etc.

The entire fulfillment of these requirements is rigorously exacted, but so far all the torpedo boats built at a German yard (Schichau) have been able to satisfy them. Even the unitiated will understand that a torpedo boat so tested can be relied upon under all circumstances and that everything necessary can be confidently expected of it. This circumstance inspires the crew with absolute confidence in their boat, a very valuable factor, to say nothing of the fact that it renders the torpedo weapon reliable, which constitutes the true value of this class of ships.

HOLLAND.

NOORD BRABANT AND CLASS.

Three vessels of this class of protected cruisers of 4,000 tons had their trials in the fall of 1899, the full results of which are giyen in the following table:

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[1] That is to say, according to the international (Beaufort) scale, moderate gale to whole gale, at a speed of 35 to 60 miles per hour, with a wind pressure of 6.6 to 17.5 pounds per square foot.

Trials of Noord Brabant and class.

GELDERLAND, (OPEN FIRE-ROOMS).

Date.	Mean draught.	Revolutions.	I. H. P.	Speed.	Coal.	Air.	Number boilers.	Duration.
1899.				*Knots.*	*Pounds.*	*Inches.*		*Hours.*
October 12	17.75	137.76	9,867	20.047	2.46	0.59–0.98	12	4
6	17.72	135.11	9,236	19.631	1.65	0.39	12	1
12	17.65	133.93	9,024	19.383	....	0.59–0.98	12	0.5
6	17.68	125.50	7,112	18.420	1.65	0.39	12	7
September 30	18.10	113.49	5,115	16.915	2.26	0.39	9	4
October 14	....	108.15	4,280	16.000	2.29	0.20–0.68	8–10	28
September 30	18.17	98.72	3,396	14.964	2.88	0.29–0.39	6	4
29	18.24	72.39	1,290	11.474	3.10	0.39–0.48	3	4
29	18.27	52.24	597	8.415	[1]4.26	0.39–0.78	2	4

NOORD BRABANT, (OPEN FIRE-ROOMS—HOWDEN).

Date.	Mean draught.	Revolutions.	I. H. P.	Speed.	Coal.	Air.	Number boilers.	Duration.
September 2	17.75	142.42	10,067	20.078	2.16	1.77–1.97	12	4
16	17.78	140.20	9,323	19.787	2.20	0.64–0.87	12	5
7	17.39	131.14	7,455	18.660	2.44	....	12	2.5
21	16.76	126.36	6,446	17.957	2.68	0.39	12	8
5	17.75	115.59	4,921	16.608	2.24	0.39	9	4
21	17.51	111.46	4,629	16.000	1.84	0.98–1.97	8	30
5	17.75	100.98	3,257	15.093	2.05	0.39	6	2
5	17.75	94.86	2,758	14.106	2.05	0.39	6	2
4	17.84	79.20	1,573	11.920	[2]2.59	0.39	4	4
4	17.98	61.24	783	9.680	[3]3.18	0.39	2	4

UTRECHT, (CLOSED FIRE-ROOMS).

Date.	Mean draught.	Revolutions.	I. H. P.	Speed.	Coal.	Air.	Number boilers.	Duration.
November 15	....	142.47	10,166	19.608	2.19	1.57–2.96	12	4
2	....	129.62	7,351	17.893	2.15	0.39–1.77	12	8
October 25	....	112.05	4,494	16.110	2.52	0.39–1.38	9	4
November 16	....	112.00	4,533	16.000	2.34	0.98	10	30
October 25	....	97.62	2,777	14.079	2.70	0.39–0.79	6	4
24	....	69.24	996	10.195	3.83	0.39–1.38	3	4
24	....	54.11	501	7.926	7.40	0.39	2	3

[1] Coal only main engines.

[2] Coal exclusive of auxiliaries, 1.90 pounds.

[3] Coal exclusive of auxiliaries, 2.02 pounds.

Details of propellers and boilers.

	Gelderland.	Noord Brabant.	Utrecht.
Propellers:			
Diameter ....feet..	13.95	14.01	13.95
Pitch ....do....	16.40	16.01	15.91
Surface ....square feet..	58.13	66.42	60.28
Boilers (12 Yarrows):			
Heating surface ....do....	25,727	25,727	25,727
Grate surface ....do....	484	455	466
Ratio of heating surface to grate surface........	53.11	56.50	55.20
Weight of engines, boilers, etc ....tons..	540.5	540.5	549.5

ASSAHAN.

This gunboat, built at Fijenord, had a satisfactory trial of her engines in November, 1900. With 1,353 i. h. p. she made a speed of 14 knots. The characteristics of the vessel are: length, 177 feet; beam, 31 feet; draught, 11 feet 10 inches; displacement, 810 tons; armament, two 4.1-in., two 12-pdr. and two 37-millimeter guns.

The results of trials of three gunboats of this class are given in the following table:

Name.	Date.	Duration.	Revolutions.	I. H. P.	Speed.	Consumption per I. H. P. per hour.
		Hours.			*Knots.*	*Pounds.*
Assahan	Sept. 5, 1900	4	225.00	1,353	14.000	2.15
Do	Sept. 4, 1900	4	180.00	845	12.000	1.96
Do	....do	4	120.00	225	8.000	3.04
Koetei	Aug. 8, 1898	4	219.46	1,412	13.513	2.23
Do	Aug. 6, 1898	4	186.30	811	12.340	2.29
Do	....do	4	120.70	208	8.380	2.26
Siboga	Aug. 24, 1898	4	219.69	1,395	13.832	2.44
Do	Aug. 25, 1898	4	188.45	853	12.314	2.18
Do	....do	4	120.00	201	8.340	3.08

OPHIR.

On March 22, 1901, this torpedo boat had her official trial, which consisted of a three hours' full-speed run at the mouth of the Thames. The mean speed attained, with a load of 30 tons, was 25.3 knots, with 1.5 inches air pressure in the fire room.

During the last week in April, 1901, an interesting trial was made on board the *Ophir* with a view to testing Holden's system of oil burning. A trial was made with coal only, when a speed of 24.5 knots was obtained over a lengthened run. Then the oil burners were started in addition to the coal supply, which remained constant throughout. With the oil and the coal together the speed was immediately increased 2 knots, i. e., to 26.5 knots. The coal burned throughout the trial was at the rate of 2,800 pounds per hour, and when the oil was supplemented the additional consumption of this fuel was 700 pounds per hour (Borneo oil). In the *Ophir* there are two boilers of equal size, and a further trial was made, at a slower speed, with oil, using one boiler, when a speed of 14 knots was readily obtained with a consumption of 500 pounds of oil per hour. The great advantage of oil burning, either alone or supplemented with coal, is that variations in evaporation can be much more rapidly made than when burning coal alone. The fire-room force in larger installations can be much reduced.

PANGRANGO.

On April 29, 1901, this torpedo boat ran her official trial in the presence of the Dutch authorities. The trial consisted of a three hours' full-speed run at the mouth of the Thames. The mean speed obtained with a load of 30 tons was 25.99 knots, with 1.5 inches of air pressure in the fire-rooms.

ITALY.

AMMIRAGLIO DI SAINT BON.

Preliminary trials of this battleship of 9,800 tons were had off Spezia early in January, 1901, and gave satisfaction. Although the fire-room force was not trained, the engines developed 9,920 i. h. p. under natural draft, and with 96 revolutions a speed of 18 knots was attained. The steam pressure on boilers was 134 pounds, vacuum 27 inches. The contract power was 9,000 i. h. p.

On May 5, 1901, she had a preliminary trial at full power off Spezia. With a steam pressure of 155 pounds in the boilers and vacuum of 26 inches she made 104 revolutions and a mean speed of 19.2 knots.

On May 23, 1901, she had her official trial at full power, forced draft. With steam pressure of 150 pounds in the boilers she made 103.7 revolutions, developed 14,277 i. h. p., and made a speed of 18.5 knots. The maximum power attained was 14,802 i. h. p. The contract called for but 13,500 i. h. p.

EMANUELE FILIBERTO.

The trial of this battleship, of the same class as the preceding, took place off Naples in September, 1900. On the natural-draft trial she started at 8 a. m., and gradually increased the revolutions from 35 to 80 at 10:40 a. m., when the trial really began. She attained a mean speed of 18 knots with 90 revolutions, and developed 9,880 i. h. p. The engines worked very well during the trial. The pressure at the engines was 150 pounds; high-pressure receiver, 125 pounds; intermediate, 25 pounds; and low, 4 pounds, with vacuum of 26 inches. The temperature in the engine and boiler-rooms was normal during the trial. The contract required a development of 9,000 i. h. p. In the trial under forced draft, the engines were speeded up from 20 to 80 revolutions between 8 a. m. and 9:30 a. m., when the blowers were started on closed ash-pits, and an air-pressure of 0.6 inch maintained. At 10 a. m. the trial commenced, during which the steam pressure at engines was kept at 150 pounds; high-pressure receiver, 140 pounds; intermediate, 48 pounds; and low, 15 pounds, with vacuum of 26 inches. For two hours a speed of 18 knots was maintained with 100 revolutions. The entire motive apparatus worked perfectly, with no signs of heating, and with little vibration, and with the steam valves wide open there was no trouble in maintaining pressure without excessive forcing. The mean power developed was 14,000 i. h. p., the maximum being 14,162. The contract called for 13,500 i. h. p. The maximum air pressure allowed was 1.6 inches, but it was not necessary to go above 0.6 inch at any time.

GUISEPPE GARABALDI.

This armored cruiser of 7,400 tons completed her acceptance trials in September, 1900, off Genoa.

On July 12, 1900, while a preliminary trial was taking place, with all of the twenty-four boilers in operation, two water tubes of steam generators Nos. 13 and 16 burst, causing the death of a coal passer and wounding two other men. When the necessary repairs had been made, the preliminary trials, interrupted by the bursting of the tubes as aforesaid, were successfully carried out on August 10.

The results of the acceptance trials, with natural and forced draft, held respectively August 17 and September 7, are given in the following table:

	Aug. 17.	Sept. 7.
Air pressure ....inch..	....	0.2 to 0.6
Number of boilers in operation	24	24
Pressure at boilers ....pounds..	176.5	204.3
Pressure at engines ....do....	138–155	138–155
Duration of trial ....hours..	6	1.50
Average number of revolutions	89.3	106
Average horse-power developed	9,948	14,713
Speed ....knots..	16.2	19.7
I. H. P. per square foot of grate surface	9.13	12.95
I. H. P. per square foot of heating surface	0.28	0.4
Coal consumption per horse-power-hour ....pounds..	1.95	....

During the trials at full power the furnaces were charged in the usual manner. As to the development of the maximum power attained, 14,713 i. h. p., being about 1,200 more than required, it may be stated that 13,500 i. h. p. could have been obtained with less forcing of the draft. The maximum speed of 19.70 could have been exceeded if, for reasons independent of the ship, it had been possible to steer the course better.

The bursting of the two tubes in boilers 13 and 16 may no doubt be attributed to the lack of experience on the part of the personnel serving the fires, who were not sufficiently skilled therein at the beginning of the trials. The main cause was that the furnaces of the boilers were charged with excessive quantities of coal, which produced excessive temperatures on the grates, so that the circulation in the inner tubes was imperfect, and the tubes themselves became red-hot. Other incidental causes concurred to render the explosion possible, but the main reason was the overcharging of the furnaces. It is well known that water-tube boilers of the heavy type, with sub-horizontal tubes, are positively not made to stand excessive forcing of the fires; to try to make them function under such conditions means to condemn them from the outset to destruction.

VARESE.

This armored cruiser, a sister ship of the *Guiseppe Garabaldi*, had her acceptance trials off Spezia in October and November, 1900, with the following results:

Date of trial	Oct. 20, 1900	Nov. 27, 1900
Duration of trial ..... hours	6	3
Draft	Natural.	Forced.
Steam pressure ..... pounds	189	201
Revolutions	95.71	105.6
I. H. P	9,479	13,885
Vacuum ..... inches	....	26
Speed ..... knots	18.36	20.02
Coal per horse-power-hour ..... pounds	1.95	1.90

The Belleville boilers and entire engine installation worked satisfactorily. The maximum power developed was 14,200 i. h. p. The contract required 13,500 i. h. p.

AGORDAT.

This torpedo cruiser has had her official trials, which were entirely satisfactory, the contract requirements being exceeded in both trials.

The first trial, February 11, 1901, was a forced-draft run of three hours' duration, in which the air-pressure in the fire-room was not to exceed 3 inches and the engines were required to develop not less than 7,500 i. h. p. The results were as follows: mean draught, 9 feet 10 inches; displacement, 1,200 tons; steam in boilers, 203 pounds; at engines, 160 pounds; air-pressure in fire-room, 2 to 3 inches; revolutions, 232; i. h. p., 8,550; speed, 22.2 knots.

The final trial was had on March 6, 1901, the vessel having then been out of dock some five months, and was a trial with natural draft of six hours' duration. An air-pressure of not more than 0.4 inch was permitted and the engines were required to develop not less than 4,400 i. h. p. The following results were obtained: mean draught, 10 feet; displacement, 1,246 tons; steam in boilers, 169 pounds; steam at engines, 155 pounds; air-pressure, 0.4 inch; revolutions, 190; i. h. p., 4,670; speed, 18.8 knots; coal consumption, 2.05 pounds per horse-power-hour.

The engines were designed to make 250 revolutions at maximum power, and the maximum speed attained was over 23 knots.

DARDO.

This torpedo-boat destroyer, of 320 tons, on a speed trial made a maximum speed of 32 knots.

FRECCIA.

This torpedo-boat destroyer, of 320 tons, has had satisfactory steam trials. On a two-hours' run at full power, with the engines making

350 revolutions, she made a mean speed of 31.20 knots. On a six hours' run at 25 knots speed the coal consumption was 1.80 pounds per horse-power-hour.

LAMPO.

This torpedo-boat destroyer, of 320 tons, had a steam trial in July, 1900. With 5,998 i. h. p. and 345 revolutions, she averaged 31.17 knots. Previous to this she is said to have made 32.4 knots during a three-hour trial.

JAPAN.

ASAHI.

This first-class battleship had her trials off Portsmouth in March, 1900. On the 21st she had a high-speed coal-consumption trial, and on the 23d a full-speed trial, each consisting of four runs over a course 12.25 miles in length.

The following were the mean results:

Date of trial	March 21, 1900.		March 23. 1900.	
Steam in boilers ... pounds	270		280	
	Starboard.	Port.	Starboard.	Port.
Vacuum ... inches	25.5	25.5	25.50	25.50
Revolutions per minute	100.4	100.5	108.40	108.30
Mean pressure:				
High ... pounds	110.2	107.6	115.21	115.32
Intermediate ... do	39.5	37.7	49.09	49.69
Low ... do	17	16.1	20.93	19.34
I. H. P.:				
High	2,223	2,170	2,508	2,516
Intermediate	2,042	1,944	2,737	2,608
Low	2,340	2,228	3,105	2,886
Total I. H. P	6,605	6,342	8,350	8,010
Collective I. H. P	12,947		16,360	
Speed ... knots	17.50		18.30	
Coal per horse-power-hour ... pounds	1.59		....	

These trials were considered most satisfactory, the ship having a mean draught of 27 feet 3.5 inches, and a corresponding displacement of 15,340 tons.

HATSUSE.

This first-class battleship, of 15,000 tons, had, on December 5, 1900, a six-hours' trial, at four-fifths power, during which a speed of 18 knots was maintained—the speed being based on revolutions.

On the 7th she had a full-power trial and ran for three hours at a speed slightly above 19 knots, the mean of four runs over the measured mile giving a speed of 19.1 knots. The mean power developed was 15,000 i. h. p. During her trials the boilers were fired by Japanese firemen belonging to the vessel.

IWATE.

This armored cruiser, of 9,800 tons, built at Elswick, on her trials in February, 1901, obtained a maximum speed of 23 knots—a good 2 knots over the contract. The mean speed during the trials was 21.8 knots.

PORTUGAL.

RAINHA D'AMELIA.

This new Portuguese cruiser had her steam trials during the month of May, 1901, as follows: a five-hours' trial under natural draft; steam in boilers, 161 pounds; revolutions, 170; i. h. p., 3,088; speed, 17.1 knots; coal consumption, 1.41 pounds per horse-power-hour. Later, on a trial of twenty-four hours' duration, she averaged 162 revolutions and made a speed of 15.75 knots.

On a three-hours' trial under forced draft, with a steam pressure in boilers of 170.7 pounds, and 200 revolutions, she developed 5,396 i. h. p. and attained a speed of 20.6 knots, with a coal consumption of 2.1 pounds per horse-power-hour.

RUSSIA.

PERESVIET.

The official trial of this first-class battleship, held in October, 1900, at full power on a six hours' trip, showed a mean speed by bearings of 19.12 knots.

On the average of five series of diagrams the indicated horse-power was as follows:

Port engine:	
High-pressure cylinder	1,292.10
Intermediate cylinder	1,616.48
Low-pressure cylinder	1,728.84
Total	4,637.42

Starboard engine, 4,445.11 i. h. p.; mean number of revolutions, 101.6; steam pressure, 143.7 pounds. Amidships engine, 4,692.84 i. h. p. The total indicated horse-power for all three engines worked out at 13,775.37, or 725 i. h. p. less than required by the specifications. This is accounted for by the irregular working of the boilers, but the engines on the whole worked well, which they did not do last year, there being a heating of the bearings. The average number of revolutions was 102, with 139 pounds pressure at the engines and 165 in the boilers.

SEVASTOPOL.

The results of the official trials of this new first-class battleship during the summer of 1900, being the mean of six diagrams, are as follows:

	Starboard.	Port.
I. H. P.:		
High-pressure cylinder	1,534.79	1,441.83
Intermediate cylinder	1,555.01	1,515.32
Low-pressure cylinder	1,647.06	1,673.56
Total	4,736.86	4,630.71
Steam pressure at engines ....pounds..	143.50	143.88
Revolutions per minute	88.14	84.00

These results give a total indicated horse-power for both engines of 9,367.57, or 1,232.43 less than the contract called for.

IMPERATOR NICOLAI I.

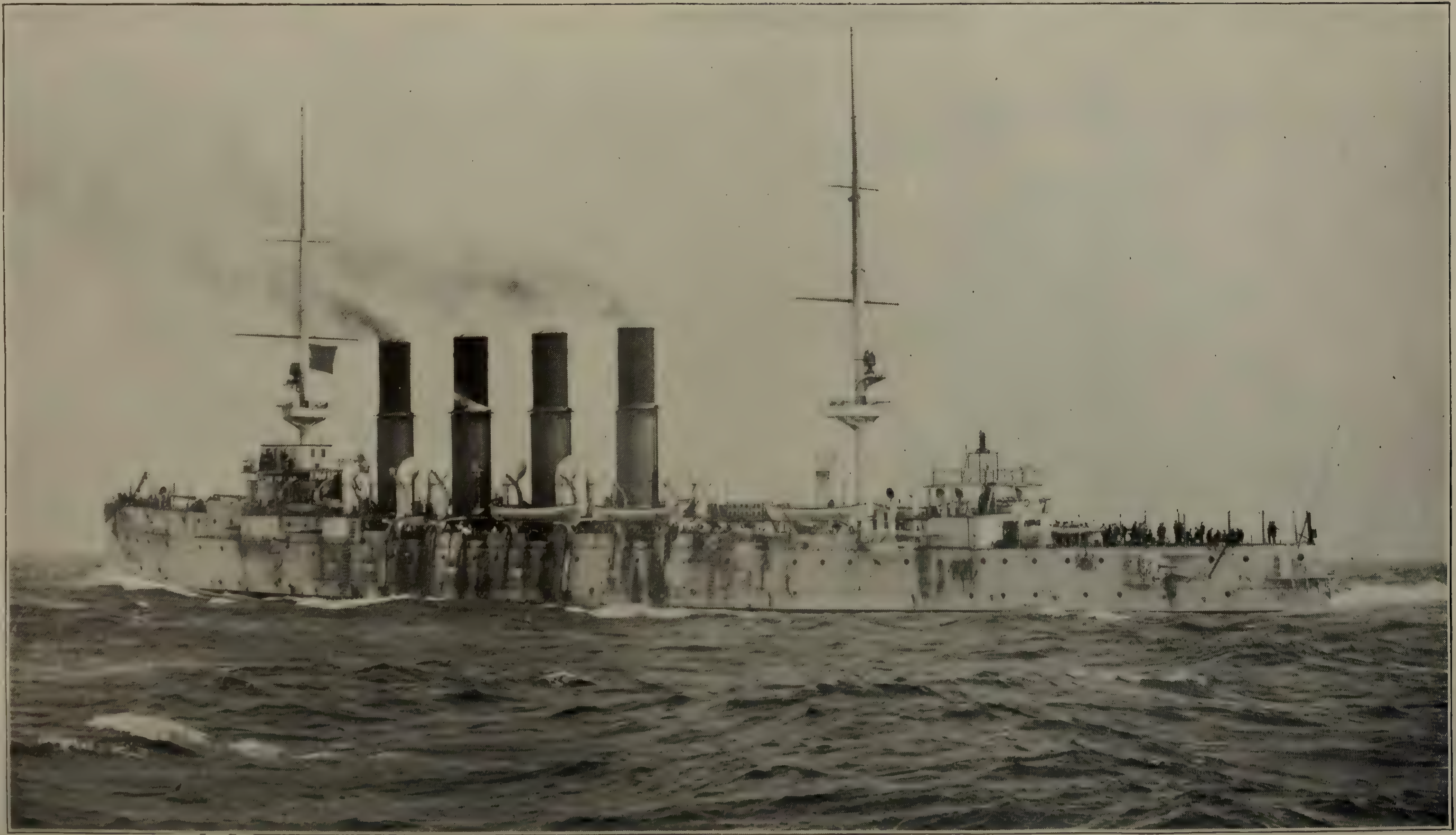
On the trials of this second-class battleship, October 30, 1900, the engines developed but 5,000 i. h. p., in place of 8,000 contracted for. This is attributed to the fact that the heating surface of the sixteen Belleville boilers is too limited, and that, instead of allowing at least 2.5 square feet of heating surface to each indicated horse-power, it allows practically 1.65 square feet.

GROMOVOI.

This armored cruiser of 12,330 tons had a six hours' full-power trial on October 18, 1900, with the following results as regards the indicated horse-power developed:

Engine.	Starboard.	Center.	Port.
Steam at engine ....pounds..	173.30	171.30	165
Revolutions per minute	124.23	117.53	123
I. H. P.:			
High-pressure cylinder	1,483.07	1,506.05	1,489.13
Intermediate cylinder	1,779.14	1,813.39	1,801.05
First low-pressure cylinder	876.16	917.57	957.41
Second low-pressure cylinder	918.20	1,037.43	917.41
Total for engine	5,056.57	5,274.44	5,165

This made a grand total for all the engines of 15,496.01, or 996.01 i. h. p. more than the contract. The total heating surface of the thirty boilers is 47,021 square feet. The amount of heating surface that went to each indicated horse-power of the engines shows the ease with which the boilers can be controlled at full speed, since they worked without forced draft and gave an excess of indicated horse-power in the engines. The speed has not been reported.



VARYAK, RUSSIAN PROTECTED CRUISER, 6,500 TONS.

ASKOLD.

This new Russian cruiser, on a trial trip on June 4, 1901, attained a speed of 22.5 knots.

VARYAK.

This protected cruiser of 6,500 tons was laid down at Philadelphia, Pa., October 13, 1898, and launched October 31, 1899. On the 28th of July, 1900, she had her first official trial trip, which was not completed because of an accident to her machinery. The trial was considered very satisfactory, though not accepted as final.

The trial was made over a 10 knot course off Boone Island, and she was gradually speeded up to 24.6 knots in the midst of a severe storm which kicked up quite a sea. The maximum number of revolutions was 160 per minute. Though the blowers were working in the fire-rooms, the doors were not closed. She was under full power for eight hours.

It was estimated by the engineers that 20,000 i. h. p. was developed. The first three runs over the course the average revolutions were 100.4, and the average speed was 16.12 knots per hour. On the fourth and fifth runs the average revolutions were 119.73, and the average speed increased to 19.07 knots. During the sixth and seventh runs the average revolutions were 141.1, and the average speed 21.93 knots. During the eighth and ninth runs the speed crept up slowly, but steadily, as the revolutions of the screws increased. The average revolutions for the two runs were 153.9, and the average speed 23.71. The eighth run was covered in 26 minutes and 15 seconds, the screws turning 153.5 times a minute, and in the ninth, when the 10 miles were reeled off in the remarkable time of 24 minutes and 22 seconds, the screws were turning 154.3 times a minute. After running seven and a half hours, and while going at a speed of 24 knots, the high pressure cylinder of the port engine was ruptured, the cylinder head breaking. At the time the steam pressure in boilers was 245 pounds, at engine 200 pounds. Fortunately no one was injured by the accident, but the trial had to be suspended.

The principal dimensions of the vessel are: length on water line, 416 feet; maximum beam, 52 feet; draught ready for sea, 19½ to 20 feet; displacement, 6,500 tons.

She has 30 Niclausse boilers, and 90 furnaces in the fire-rooms. The grate surface is 1,575 square feet, and heating surface 62,229 square feet. The four smoke-pipes rise 90 feet above the grate bars. The diameters of cylinders are, high, 40 inches; intermediate, 62 inches, and two low of 68 inches; length of stroke, 3 feet.

A matter of importance is the performance of the Niclausse boilers, which in generating steam and in facility of firing exceeded all expectations. The full horse-power required was easily produced under natural draft, while 10 per cent of the furnaces were under process of cleaning and hoisting ashes, showing that the ship has a wide margin of excess of steam-generating capacity. The average horse-power developed in the run of 23.7 knots per hour was about 17,000.

While it is noted that natural draft only was used, the 60-inch fire-room blowers were kept constantly running, except when some were temporarily shut down in order to hoist ashes. This is what might be termed assisted draft, although there was no air pressure in the fire-room, by gauge.

Results of official trial.

[2:03 p. m. to 9:30 p. m., July 28, 1900.]

	Starboard.		Port.	
	M. E. P.	I. H. P.	M. E. P.	I. H. P.
Average high-pressure cylinder	85.9	3,018	84.5	2,965
Mean-pressure cylinder	28.2	2,373	27.6	2,327
First low-pressure cylinder	12.1	1,232	11.3	1,143
Second low-pressure cylinder	12.1	1,233	11.8	1,195
	M. R. P.		M. R. P.	
One engine	38.97	7,864	37.82	7,631
Two engines	....	15,495		....
Revolutions	152.75		152.9	
Opening of throttle	.15		.15	
Steam pressure ... pounds	230		232.3	
First receiver ... do	190		191.3	
Second receiver ... do	56.1		51.2	
Third receiver ... do	10.5		9.6	
Vacuum	22.5		23.3	
Cut-off high pressure ... inches	3.25		4	
Mean pressure	.740		.740	
First low pressure	.753		.753	
Second low pressure	.709		.709	
Steam to receiver	Closed.		Closed.	
Average double strokes air pump	14.7		13	
Revolutions circulating pump	173		190	
Temperature injection ... °F	62		62	
Temperature discharge ... °F	126		122	
Temperature hot well ... °F	82.5		86	
Temperature starting platform ... °F	96		97	
Mean speed ... knots	23.6			
Slip ... per cent	15.4			
Draught	19 ft. 6.75 in.			
Displacement ... tons	6,500			

FIRE-ROOM CONDITIONS.

Two p. m. to 9:25 p. m., July 28, 1900. Average pressure on all thirty boilers, 243.5 pounds.

Fires thin, about 9 inches thick. Firing good.

One-half glass of water carried on all boilers.

Outside of uptake hot, between 300 and 400° F.

Temperature of passage between boiler and bulkhead, 127° F.

Fire-room, numbered from forward.	1.	2.	3.	4.	5.
Average speed feed pump, double strokes, per minute	29.25	26	23.87	36.14	28.71
Pressure at pump..............pounds..	289.37	357	378.12	410.71	345.71
Steam pressure..................do.....	249	243.43	248.015	238.75	240.07
Temperature of feed water at pump..°F..	81.50	83.50	....	84.07	84.20
Number revolutions of blowers...........	402.40	400.87	396.43	398.50	387.37
Air pressure..............................	0	0	0	0	0
Temperature of fire-room on floor....°F..	90.37	92.12	98.37	94.28	103.87
Temperature of fire-room on gratings.°F..	114.25	112.50	123	134.87	157

BLOWER CONDITIONS.

The motors ran well; no sparking; bearings cool. Foundations firm; no vibration.

No. 1 blower shut down from 7:10 p. m. to 7:55 p. m. to permit hoisting ashes.

No. 3 and No. 4, blowers shut down 7:20 p. m. for same reason.

No. 9 and No. 10, blowers shut down 7:35 p. m. for same reason. Were still shut down when trial ended, 9:25 p. m.

Boilers held steam well after blowers were stopped.

Average number of revolutions for sixteen blowers, 397.44.

A thorough examination of the boilers after this run showed no signs of distress.

On the 1st of October she had a six-hours' coal-consumption trial, and demonstrated her ability to steam 6,250 miles at 10 knots on her full fuel supply, which is 1,250 miles in excess of the contract. On the 4th of October she had a trial of twelve hours' duration, during which she was required to maintain a speed of 23 knots. She was run with 149 revolutions, and an average speed of 23.25 knots was maintained without difficulty. The highest speed attained was 24.2 knots, which was not the highest possible, as she was not forced. The trial was under natural draft.

The speed was deduced from the standardization data of the propeller, obtained by previous runs over a 10 mile course in July, four runs (two each way) being made over the course at each of four different speeds far enough apart to establish points for plotting a speed-revolution curve, and from which the speed of the final trial could be obtained simply from the revolutions. The results of these standardization runs were:

No. 1.—Speed, 16.122 knots; average revolutions, main engines, 100.2; i. h. p., main engines, 4,371.

No. 2.—Speed, 19.6 knots; average revolutions, main engines, 119.7; i. h. p., main engines, 6,975.

No. 3.—Speed, 21.97 knots; average revolutions, main engines, 140.8; i. h. p., main engines, 12,107.

No. 4.—Speed, 23.7 knots; average revolutions, main engines, 153.4; i. h. p., main engines, 16,206.

FOREL.

On April 30, 1901, this torpedo-boat destroyer had her official trial at full speed, and maintained a speed of 27.1 knots with 300 revolutions, which was considered very satisfactory, as the contract only called for a speed of 26 knots.

OSETR.

During the last week in May, 1901, this torpedo-boat destroyer had her official full-speed trials, which were very successful. She maintained a speed of 27.3 knots, instead of 26 required by the contract.

STERLIADE.

During the latter part of May, 1901, this torpedo-boat destroyer, built by Normand & Co., for the Russian Government, had her official trials, which were very satisfactory, the speed attained being 27.381 knots.

SWEDEN.

NIORD.

The trials of this battleship took place off Gottenborg, on January 27, 1899, in very rough weather, and everything worked satisfactorily.

The mean draught of the ship was 15 feet 11 inches.

During a four hours' trial, with natural draft, the mean steam pressure was 157 pounds; revolutions, 110.84 per minute; i. h. p., 3,768; speed, 15,027 knots. During a trial of one hour and eighteen minutes, with forced draft, the mean steam pressure was 158 pounds per square inch; air pressure, 0.6 inch; revolutions, 120.50 per minute; i. h. p., 5,077; speed, 16.032 knots.

The coal consumption with natural draft was 1.68 pounds, and with forced draft 2.37 pounds per horse-power-hour.

THOR.

This vessel, a sister ship of the above, had her trials about the same time, and they gave practically the same results.

JACOB BAGGE.

This torpedo cruiser of 700 tons had her acceptance trials during the summer of 1900, the results of the forced-draft trial being as follows: draught forward, 8 feet 9 inches; aft, 9 feet; steam pressure, 176 pounds; air pressure, 0.8 inch; revolutions, 232; i. h. p., 3,973, speed, 19.5 knots; coal consumption, 1.87 pounds per horse-power-hour. She is fitted with four locomotive boilers.

PSILANDER.

This torpedo cruiser of 700 tons had her trials in August, 1900, with satisfactory results. The contract called for 4,500 i. h. p. and 20.5 knots under forced draft. She is fitted with eight Yarrow boilers, and with natural draft made 19.3 knots, with 2,946 i. h. p. On the forced-draft trial the results were as follows: draught forward, 8 feet 9 inches; aft, 8 feet 11 inches; steam pressure, 205 pounds; air pressure, 1.4 inches; revolutions, 260; i. h. p., 4,775; speed, 20.7 knots; coal consumption, 2.35 pounds per horse-power-hour.

She was constructed at the Bergsund Works, at Stockholm.

BLIXT AND CLASS.

BLIXT, BRIS, METEOR, ORKAN, STJERNA, AND VIND.

These vessels have two water-tube boilers each. During trial trips on the measured mile the *Blixt*, with a draught of 3½ feet forward and 6.65 feet aft and a displacement of 77 tons, made 23.545 knots with forced draft, with a steam pressure of 204 pounds, and air pressure of 1.7 inches in the forward fire room and 2 inches in the after fire room, 375 revolutions per minute, and 1,225 i. h. p.

With a draught of 5.4 feet forward and 7 feet aft, and a displacement of 94 tons, the results were as follows: Steam pressure, 203 pounds; air pressure, forward, 1.6 inches, aft, 1.7 inches; revolutions, 355; i. h. p., 1,217.

The slowest speed was an average of 21.013 knots during a trial trip of two hours' duration.

The best speed of the six torpedo boats was made by the *Bris*, namely, 24.18 knots average on two runs, with 24.33 knots one way and 24.03 the other.

With natural draft these boats can attain a speed of about 18 knots with both boilers and of 14.5 knots with only one boiler in operation.

The coal consumption, with the vessels fully equipped, is shown in the following table:

Speed.	I. H. P.	Coal per horsepower per hour.	Number of boilers in operation.
Knots.		*Pounds.*	
10.02	70	6.61	2
11.64	124	3.04	1
14.53	278	2.45	1
18.15	765	2.27	2
21.01	1,217	3.31	2

TURKEY.

A AND B.

These torpedo-boat destroyers, constructed by Messrs. Ansaldo, of Genoa, on their trial trips developed 2,400 i. h. p., and maintained speeds of 27.1 and 27.4 knots, respectively. The designed speed was 26 knots.

They left Genoa for Constantinople May 6, 1901. They were ready for delivery in March, 1901, but were withheld until the Turkish Government should have paid for them. Positive information as to the payment for the boats has not been received, but it is presumed that payment has been made.

The dimensions of the boats are: length between perpendiculars, 159 feet 1 inch; length over all, 165 feet 7 inches; beam, 18 feet 6 inches; mean draught, 4 feet; displacement, 145 tons; bunker capacity, 60 tons; radius of action at 14 knots, 2,000 miles.

The armament consists of two R. F. guns and two torpedo tubes.

SECTION IV.

RECONSTRUCTION OF OLD SHIPS.

ENGLAND.

TORPEDO GUNBOATS.

The torpedo gunboats *Circe*, *Gossamer*, *Jason*, and *Niger*, built in 1892, are to be fitted with new engines and boilers. They are at present fitted with engines of 3,500 i. h. p. and locomotive boilers. Water-tube boilers of small-tube type are to be fitted and are to be associated with light, quick-running engines, estimated to develop 6,000 i. h. p.

The *Skipjack* was recently fitted with new engines and small-tube water-tube boilers, with most successful results, her engines indicating upward of 6,000 i. h. p., while her speed was increased from 17.5 knots to just above 20 knots.

FRANCE.

DÉVASTATION.

The reconstruction of this old battleship has been completed during the year, and has affected the hull, armament, engines and boilers of the ship.

To lighten the hull the armor has been replaced by thinner plates of the same efficiency as the old and part of the superstructure has been removed. The result is that the water-line protection, formerly very imperfect, since it was too much submerged, is very much improved. The total decrease in displacement is about 200 tons. A cofferdam was fitted on the lower deck.

The new armament, it is now stated, will consist of four 10.8-in. guns, latest model, in battery behind stout shields of modern steel; two 9.6-in. guns, latest model, in barbettes behind shields on the upper deck above the battery, and four 4-in., two forward and two aft. The ten 4-in. substituted for six 5.5-in. some time ago will remain. The result is—

Original armament.	Suggested.	New armament.
Four 12.6-in. (old coast gun)	Eight 10.8-in. (old model)	Four 10.8-in. (model 1893)
Four 10.8-in. (model 1880)	Ten 4-in. (model 1892)	Two 9.4-in. (model 1893).
Six 5.5-in. (model 1881)		Fourteen 4-in. (model 1892).

The penetrations of the new heavy guns are far better than the old, but the shells are, of course, smaller. There is a big difference in the rate of fire.

The old engines have been replaced by triple-expansion engines, and a speed of 15.5 knots is anticipated. The old cylindrical boilers have been replaced by Belleville boilers.

FORMIDABLE.

This first-class battleship has been reconstructed at Lorient. She was launched April 16, 1885.

Her dimensions are: length between perpendiculars, 321.5 feet; length over all, 343 feet; beam, 70 feet; mean draught, 27 feet 2 inches; projection of spur, 12 feet; load displacement, 11,900 tons.

The hull is entirely of steel. The belt is of plates varying from 10 inches forward to 6 inches aft, and amidships of a thickness of 16 inches, and of widths, respectively, of 11.5, 6.25, and 8 feet. The protective deck has a thickness of 4 inches. The turrets have 16 inch armor.

The 14.5-in. guns amidships have been replaced by four 6.5-in. guns in two armored casemates, and those in the forward and after turrets have been replaced by 10.8-in. guns of 40 calibers.

The after military mast has been removed and replaced by a signal mast, and bilge keels have been supplied to suppress rolling motion.

HOCHE.

This battleship has been recently reconstructed almost throughout, and has had steam trials which show she has been improved in speed and facilities for changes of speed, owing to new boilers.

As originally built, she had her armor belt entirely submerged, and was known as the submarine battleship. Now the top of the belt is fully 2 feet above the water-line.

All the superstructures have been removed, and she has now but one military mast and a signal mast, and the military top is trapezoidal in shape instead of circular. All wood has been removed as far as possible and replaced with corrugated steel plates.

The dimensions are: length, 395 feet; beam, 66 feet; mean draught, 27 feet; displacement, 10,500 tons.

The armor belt goes from bow to stern, and is of the following thicknesses: Forward, 15.75 inches; amidships, 17.75 inches; aft, 13.75 inches. The protective deck is 3 inches thick, and the turrets 15.75 inches thick.

The turret guns remain the same. The eight 5.5-in. guns have been placed in two groups just abaft the forward turret, and forward of the after turret, in the superstructure. Two of each group are on the main deck, one on either side, and two on the deck above, just over

HAGEN, GERMAN BATTLESHIP, 4,114 TONS.

them. Four 65-millimeter guns are placed on bridges just above the guns last mentioned.

The engines have been replaced by triple-expansion engines of 10,800 i. h. p., and the old cylindrical boilers by Belleville boilers. The dynamos have been replaced by others of double the capacity. The speed is now 16 knots, and radius of action 1,000 miles.

REQUIN.

In consequence of unexpected delays, the work on board the coast-defense battleship *Requin*, which has been undergoing reconstruction, did not proceed as rapidly as was expected. She was, however, placed in commission with a reduced complement on May 15, 1901, for her trials after reconstruction. The *Requin*, which is one of a class of coast-defense ships of 7,800 tons, built some fifteen years ago, had a steel water-line belt of the enormous maximum thickness of 19.5 inches, while she carried two 16.5-in. guns, as her heavy armament, in barbettes protected by 17 inch armor, one forward and one aft. When fitted up with coal and stores the belt in all these ships was below the water. Some of the armor has now been removed, two 10.8-in. guns in closed turrets have been substituted for the 16.5-in., and the armor on the new turrets reduced to 9 inches; altogether the ship has been lightened to the extent of over 600 tons, and it is hoped now that at load draught the upper edge of the belt will be at least 18 inches above water. Niclausse boilers have been substituted for her old cylindrical ones, all superfluous wood fittings have been removed and steel decks supplied. The expense of reconstruction will exceed 2,000,000 francs ($386,000).

GERMANY.

HAGEN.

This coast-defense ironclad, one of the eight ships of the *Siegfried* class, has been reconstructed and the work completed during the past year. She has been lengthened by separating the two ends of the vessel and building in a new section, and has received new boilers and engines and changes in armament and protection. The reconstruction having been successful in the case of this vessel, the same treatment is to be applied to the other vessels of the same class.

The trials of the *Hagen* have shown that the advantages sought to be gained by the lengthening of the ship have been fully realized.

The coal capacity of the *Hagen*, which before the reconstruction was 220 tons in bunkers and could be increased to 320 tons by carrying 100 tons of coal in sacks, is now 580 tons, which can all be stowed in bunkers. The ship's radius of action at 10 knots' speed has therefore been increased from 2,000 miles to 3,500 miles, and can probably be still further increased when oil is used as fuel. In this connection it should be noted that the computation of the radius of action is not based on the coal consumption usually assumed in technical publications, namely, about 2.2 pounds per unit of power per hour, but on the comparatively high consumption of 3.3 per unit of power per hour, wherein ample allowance is made for the many needs of the ship in the way of water supply, lighting, operation of auxiliary engines, as also for lessening the boiler efficiency as a result of clogging of the tubes.

Before the reconstruction the *Hagen*, with her locomotive boilers, with an air pressure of 1.8 inches, water column, had a maximum efficiency of 4,545 i. h. p., and a speed of 14.85 knots. With her Thornycroft boilers the maximum efficiency, with an air pressure of 0.8 inch water column, is now 5,250 i. h. p., and the speed with 5.000 i. h. p. is 15 knots.

The speed measurements made during the trials demonstrated that the lengthening of the ship has had a favorable influence upon the speed conditions at full power, since the wave-forming resistance has been decreased. At mean speed (10 to 14 knots) a somewhat higher engine efficiency is required than formerly, which fact may be attributed to the influence of the increased frictional resistance due to the lengthening.

The maneuvering capabilities of the ship have undergone but little change. The tactical diameter, which before the reconstruction, at 12 knots speed with both screws ahead, was 400 yards, is now 432 yards, or 32 yards more.

The stability trials have shown that the stability of the ship has been improved to such a degree that it has become admissible to reinforce the former 12 inch turrets of the 9.4-in. guns.

In addition to the foregoing, the following improvements have been realized through the lengthening of the ship:

The armament has been increased by two 3.4-in. R. F. guns and six 37-millimeter machine guns.

The forward signal mast has been replaced by a military mast, as was also done in the cases of the *Odin* and *Aegir*, and the fighting top has been armed with two 37-millimeter machine guns.

The two 14-in. above-water broadside launching tubes have been removed and replaced by 18-in. submerged broadside tubes. The 14-in. above-water stern tube has been replaced by an 18-in. armored tube.

The 3.1 inch steel conning tower has been replaced by a 7 inch face-hardened, nickel-steel conning tower.

Moreover, through the skillful appointments of the living quarters, the superior arrangements of the ventilation and lighting, etc., the ship has been rendered considerably more habitable.

The following comparative table will show in a comprehensive manner the changes resulting from the reconstruction of the ship:

	Before reconstruction.	After reconstruction.
Length between perpendiculars	239.5 feet	267 feet.
Extreme breadth	49 feet	49.20 feet.
Mean draught	17.50 feet	17.50 feet.
Displacement	3,500 tons	4,114 tons.
Armament	Three 9.4-in. guns, eight 3.4-in. R. F. guns, six 8-millimeter automatic guns.	Three 9.4-in. guns, ten 3.4-in. R. F. guns, six 37-millimeter machine guns, four 8-millimeter automatic guns.
Torpedo armament	One 14-in. submerged bow tube, two 14-in. above-water broadside tubes, one 14-in. above-water stern tube.	One 14-in. submerged bow tube, two 18-in. submerged broadside tubes, one 18-in. above-water stern tube, armored.
Conning tower	3.1 inch steel	7 inch face-hardened nickel-steel.
Rigging	1 signal mast	1 military mast.
Maximum engine efficiency	4,545 I. H. P.	5,250 I. H. P.
Speed with above efficiency	14.85 knots	15 knots.
Boilers	4 locomotive	8 Thornycroft.
Smoke-pipes	1	2.
Bunker capacity	220 tons	580 tons.
Complement	276 men	297 men.
Supply of provisions	For 4 weeks	For 6 weeks.

PORTUGAL.

VASCO DA GAMA.

This old coast-defense vessel has been thoroughly overhauled and modernized. She has been fitted with water-tube boilers in separate compartments, with additional coal protection, and has received a new armament, consisting of four 8-in. R. F. guns in 8 inch turrets, four 4.7-in. R. F. guns—one forward, one aft, and two on the sides—eight 3-pdr. semi-automatic guns, and two 1-pdr. automatic guns. She has also been fitted with two submerged torpedo-launching tubes.

RUSSIA.

ERMACK.

A difficult and important piece of work in the shipbuilding line was completed on the Tyne in November, 1900. This was the reconstruction of the ice-breaking steamer *Ermack* for the Russian Government.

Powerful as this vessel proved herself in attacking the field ice in the Baltic and in the Kara Sea, it was found by experience that she would be better without the forward propeller and the machinery that was fitted in her stem. Consequently she was taken to the Tyne and fitted with a new bow as well as lengthened some 15 feet.

The first stages of the operation were to cut away as much of the old bow as was possible without docking the ship, and the building of a new bow. This was built on shore and launched in September, 1900. It was very strongly built, with double plates, and frames quite close together, but as its form was such that without extraneous buoyancy it would not have sufficient stability to maintain it in an upright position, a steel pontoon was built and securely riveted to the sides of the bow, extending under its whole length. Ballast was carefully placed so as to prevent any tendency of the bow to tip during the launching, and special precautions as to shoring and timbering were carried out. The curious looking structure went into the water without difficulty and floated within an inch of the calculated draught. The length of the new bow was 75 feet and its launching weight 500 tons.

On October 1, 1900, the ship and the new bow were floated into a dock and settled on the blocks. The remainder of the old bow was cut away and the new bow adjusted and connected. This was successfully completed, the pontoon cut away, and the ship left the dock 15 feet longer than before and vastly stronger in the stem. She was engaged during the past winter in keeping open the Russian Baltic ports.

SECTION V.

SHEATHING OF SHIPS.

ENGLAND.

There has been much discussion in regard to the sheathing of ships in recent years, and the following notes will be of interest as showing the trend of opinion abroad.

The practice of sheathing war vessels with wood and copper, which had in recent years become so common, was intended primarily to enable the vessels to have continued cleanness of bottom, and thus maintain a minimum resistance to propulsion, even though they had to keep the sea for long periods and were for years on foreign stations where there was no suitable dry-docking accommodation and in waters where they were exposed to very rapid fouling.

Another advantage claimed for sheathing war vessels is that the wood planking outside a steel skin adds to its capability of taking hard rubs; and thus we find about six years ago Sir William White stating: "For many of the services which have to be performed by the smaller classes of H. M. ships, it is most desirable to have a stout wood bottom protected by copper. Bare thin iron or steel plating is unsuitable, under such conditions, both to withstand the shocks of grounding and the risk of serious and rapid corrosion in tropical waters containing large quantities of vegetable matter;" and, he pointed out, "that while formerly such small vessels were of composite construction, now sheathed vessels were employed."

The practice of sheathing the bottoms of vessels is, however, not without serious drawbacks, foremost among which is the greatly increased cost; but this, if the sheathing was in every way satisfactory, would be of minor importance, and would be possibly almost neutralized by the lessened expenditure of fuel in maintaining a high speed, and by the saving effected by less frequent docking and cleaning. In bygone years the adoption of iron bolts in fastening the sheathing resulted in their rapid deterioration, owing to galvanic action, but now it is usual to adopt bolts of naval brass; and as long as these metal bolts can be kept perfectly water-tight, and the salt water prevented from getting into contact with the steel plating and framing, all is well. This desirable condition is, however, not always maintained, and, owing to the failure to absolutely exclude sea water, in some cases the steel plating has been badly attacked, while in other instances the fitting of the sea valves and other connections have been seriously damaged. During August, 1900, H. M. cruiser *Ariadne* was found to be leaking at her moorings at Portsmouth, and it was assumed that a Kingston valve had been left open, but after the vessel was dry-docked it was ascertained that the corrosion of the bolts both inside and outside the hull had been so extensive that the mounting of one of the under-water fittings had fallen off, allowing a great inrush of water. The corrosion of the outer bolts of H. M. cruiser *Spartiate*, a sister vessel, had previously been detected, and on further examination it was found that the inner bolts had also been corroded. Similar experiences have occurred in foreign war vessels which have wood and copper sheathing, and it is said that the Russian admiralty is dispensing with wood and copper sheathing in vessels now being built, although in the new coast-defense ironclad *General Admiral Apraksin*, now under construction, the bottom will be wood sheathed but covered with steel instead of copper sheets.

There is another objection to the use of copper sheathing which appears to be well grounded, viz, its injurious effect on vessels which are not so sheathed, owing to a galvanic current being set up and severe corrosion ensuing in the unsheathed vessel. Such an experience, it is stated, recently occurred to a steel vessel of the Italian navy moored to the same buoy with a copper-sheathed vessel, and a similar occurrence is reported from Kronstadt.

Undoubtedly the great reason for using copper sheathing is because of its anti-fouling qualities, but even in this respect its efficacy is being questioned, and apparently not without reason. According to the *Kronstadt Vestnik*, the Russian first-class cruiser *Pamyat Azova*, which had a copper-sheathed bottom, always showed on dry-docking at Vladivostock a very foul bottom, whereas other ships not copper sheathed, but coated with an anti-fouling composition showed much less marine growth, although both classes of vessels were stationed in the same waters. It also appears that a few years ago, probably owing to the experience just related, it was decided to coat a few square yards on the bottom of the cruiser *Pamyat Azova* with Holzapfel's anti-fouling composition, and when in the following year the vessel was again dry-docked the composition was perfectly clean. This trial has been repeated on a larger scale, and should it again prove successful, as is probable, the question arises, Why continue at such an enormous expense to apply wood and copper sheathing? It must be remembered that in recent years there have been great advances made in the manufacture of anti-fouling compositions, the skill of the most eminent chemists having been requisitioned to secure improved mixtures, and it is only reasonable to anticipate that a composition can be manufactured with at least as effective anti-fouling qualities as copper sheathing.

Commenting on the fact that in recent discussions in Parliament regarding the cost of the new royal yacht *Victoria and Albert*, no question was raised as to why she was sheathed, an official of the Devonport dockyard writes as follows:

> The question of the sheathing of the royal yacht, however, is a small one compared with the fleet as a whole. A great number of our cruisers are sheathed, as well as a larger number of smaller ones, thus increasing their initial cost and sacrificing at least half a knot in speed. Is this necessary or expedient? The number of our docks abroad is increasing, and very soon there will be ample facilities for docking ships on all stations, and stations where there are no docks are patrolled only by small ships. Except in the case of these small ships there is absolutely no reason why the whole of our ships could not be docked once in six months, or even oftener, without unduly interfering with dockyard or ship work. The operation could easily be performed in two or three days, or in a much shorter time in cases of emergency. The cost of docking and of the composition applied would be more than covered by the saving in coal burned in steaming, the ship would maintain her speed better and have a larger radius of action. With this increase in docking facilities the necessity for sheathing ships as a protection from corrosion diminishes to a vanishing point. To sheathe a ship with copper for its anti-fouling properties alone is not only not worth the initial outlay, but really results in a great waste of money for extra coal burned and also a great loss in efficiency. On stations where there are docks it is the custom for sheathed ships to be docked once a year. At the end of the year, however, the bottom of such a ship will be found to be in a worse state than the bottom of an unsheathed ship which is docked every six months, in spite of the anti-fouling properties of copper. Where there is only a little weed on the latter ship, the former will be found covered with minute shells of various organisms and embryo barnacles. Consult the log of the sheathed ship and the engine-room register, and compare the vessel's speed at the beginning and the end of the year, and the result is startling. Again, compare these results with the performances of a sister vessel, which (being unsheathed) is docked every six months, and the result is still more startling.
>
> The second-class cruisers of the *Cambrian* class, which are all sheathed, have experienced a reduction in speed from 18½ knots to 16½ knots, and even more in a year, while the increase in coal expenditure amounts to tons per diem. The *Diadem* class shows a similar falling off in speed. The anti-fouling properties of copper presuppose that it is originally clean and smooth on leaving dock; this may be the case on first leaving the dockyard, but unfortunately it is not always the case during periodical dockings of a ship's commission. We have reason to believe that the Admiralty are beginning to doubt or are not satisfied with the superior anti-fouling qualities of copper, because at the present time and for the past two or three years they have been experimenting with a composition for coating copper-bottomed ships. Why should it be necessary to go to the expense of coating sheathed ships with anti-fouling composition if copper is really as effective as is believed? As a matter of fact, we are of the opinion that the necessity for coating sheathed ships does not arise from a mistaken idea of the merits of copper, but the reason may be traced to the fact that insufficient attention is paid to the cleaning of ships' bottoms while in commission. The usual plan is to scrub down as the water is pumped out of the dock, and this is probably good enough for a six months' docking, when there is a little more than weed on the ship. The scrubbing is done by the ship's crew, and when, later on, the dockyard painters come along to put the composition on, they remove any roughness that may be left before applying it. With a sheathed ship, however, which is not to be painted, the scrubbing as the water is pumped out, as a general rule, has to be sufficient. As there is no composition to be applied, the immediate necessity for

making the ship's bottom absolutely smooth is probably not taken into account, and the consequence is that a rough surface is formed by myriads of minute shells, which remains as a nucleus for future growth. Cleaning a ship's bottom ought not to be treated as an evolution to be performed as quickly as possible, but the chances are that the work being altogether outside the commanding officer's usual routine (already broken into by the ship's being in dockyard hands, and the demand for working parties, range parties, etc., being more urgent), the time for cleaning the ship's bottom is cut down to the shortest possible limits. This is shown by the following illustration:

Two or three years ago two sister ships, both sheathed, were docked at the same time side by side. Both had the usual scrub down as the water was being pumped out of the dock, the operation being apparently completed at the same time. The dockyard officials thought, however, that one of the ships on being docked had a much larger growth than she ought to have had since the previous docking. The consequence was that they applied for and received permission to try the effect of a special coating of anti-fouling composition for copper-bottomed ships. In order to watch the effect properly, only one side of the ship was to be coated, the other side to be left bare. When the painters arrived to apply the composition, they found that it was absolutely useless to attempt to apply paint to the so-called clean bottom, and a squad of men were specially applied for days in scraping off the minute shells that still adhered after the ship had been scrubbed down. This having been done and the paint applied, the other side of the ship had also to be scraped and cleaned with similar care in order to make a fair comparison. Whether the coated side or bare copper side proved the superior, history does not relate; but the same green composition is still being applied to sheathed ships, and it may be presumed that it is still under trial or its superiority over bare copper has been proved. Shortly after the two ships in question were completed both were sent on a voyage practically in company, going the same distance in the same time and experiencing the same weather. The speed was 11 knots, and both ships started with four boilers alight; but whereas the ship which had been properly cleaned maintained its speed with perfect ease and comfort in the fire-room, the other ship, after struggling hard to maintain the same speed, eventually had to light another boiler. Comparisons at the end of the trip showed one ship averaged eight or nine revolutions more than the other for the same speed and with an increased consumption of 10 or 12 tons a day. Comment is superfluous.

This illustration may not form a conclusive argument against the sheathing of ships, but it must be remembered that this was a case of a fair comparison between two ships which were supposed to leave the dock in the same clean condition. It is not the theoretical value of sheathing that has to be considered, but the result of working under general service conditions. No unsheathed ship would have been allowed to leave dock in the rough state of one of the ships mentioned above, and it must be remembered that the other would have left in a similar state but for the fact of trying an experimental coating of paint. The case of these two ships is probably not an isolated one, and, if sought for, many more examples could be found where the sheathing of ships has perhaps indirectly been the means of keeping the bottoms in a continually foul state.

The following note is favorable to sheathing. It is stated that the *Powerful* was not docked for two years and three months, and that there had been very little decrease in her speed due to a foul bottom at any time during her foreign service. She therefore affords a striking argument for the other side of the question.

GERMANY.

It is stated that the Germans will discontinue sheathing their large ships. They claim that recent improvements in anti-fouling paints, etc., will render it unnecessary to dock a ship oftener than once a year, and in that time their experience shows that the outboard delivery valves and other openings in the under-water body become so foul that even a sheathed ship must be docked yearly, and therefore no advantage is gained by sheathing.

The average speed of a ship that has been sheathed will be less than that of an unsheathed ship with a displacement that is much less than that of the sheathed ship, corresponding to the increased displacement due to the sheathing. The unsheathed ship will have a higher maximum speed when clean, and after a year's cruising in the worst tropical waters she will be as fast if not faster than the sheathed ship of the same horse-power but having a displacement greater by the extra displacement due to her sheathing. The expense of sheathing and the difficulties and expense of repairing sheathed ships are so great as to decide in favor of unsheathed ships.

ITALY.

The Italian Minister of Marine states that the Italian battleships and armored cruisers are not to be sheathed. He is of opinion that the expense is too great to make it advisable. It might save frequent docking, but it is found to be necessary to dock ships not only to clean their hulls, but also to examine the under-water fittings, and the sheathing does not obviate the necessity of docking entirely. The anti-corrosive and anti-fouling paints used by the Italian navy, though not perfect. are very good and keep the hulls of their ships fairly well. Small cruisers destined for long cruises in foreign waters might be sheathed to advantage, but the cost for larger ships and the increased displacement caused by sheathing render it inadvisable for them.

SECTION VI.

COALING RECORDS.

The question of time in coaling has been given much attention in recent years, and efforts are making to shorten the time necessary for this important evolution.

The following notes in regard to coaling in the English and German navies may be of interest:

On August 24, 1900, the *Furious*, protected cruiser, 5,750 tons, did some excellent coaling work, believed to be the record for a cruiser. She filled her bunkers completely at the rate of 124.7 tons per hour.

In October, 1900, it was reported that up to that time the best record was held by the English navy—180 tons per hour—but that it had been beaten by the *Weissenburg*, German battleship, which took in 182 tons in one hour. It is not stated, however, that this rate was maintained during the coaling.

During the first half of November, 1900, several ships of the English navy had a coaling competition at Berehaven, with the following results:

Ship.	Class.	Displacement.	Amount taken.	Average tons per hour.
			Tons.	
Majestic	Battleship, first class	14,900	559	144
Mars	do	14,900	632	134
Magnificent	do	14,900	510	123
Repulse	do	14,150	682	98
Resolution	do	14,150	500	[1] 91
Furious	Protected cruiser, second class.	5,750	400	72

[1] The *Resolution* had her Temperley transporter disabled for one hour and forty minutes.

In January and February, 1901, five battleships of the English Channel Squadron engaged in a coaling competition at Portsmouth to test new arrangements there. As the ships were practically without coal, it was considered desirable to ascertain how rapidly, with full use of all available appliances, a battleship could be coaled, and it was shown that any ship could be supplied up to 1,500 tons during daylight of one day. To effect this, three cranes were kept at work on the shore side, and on the water side were two Temperley vessels with two transporters on each. The question therefore arose whether the crew could stow the coal as rapidly as it could be shipped. It was also determined to give, as far as possible, each ship the same chance; but this condition could not be fully observed, for while four of the vessels coaled in daylight, the *Prince George* had three hours of artificial light, from 5:30 to 8:30 p. m. In each case, however, every detail of the operation was carried out by the ships' companies, the only outside assistance being rendered by the dockyard men, who worked the winches on shore. The work, even to bringing the lighters alongside and running the coal to the cranes, was performed entirely by the crews. So keen was the competition that not only lieutenants, but even chaplains, paymasters, and surgeons threw themselves into the work, and wheeled their loads with the energy and rapidity of trained firemen. The following is a return of the operations on the five ships:

Ships.	Date.	Amount taken.	Working hours.		Average tons per hour.
		Tons.	*h.*	*m.*	
Hannibal	Jan. 14	943	5	35	170
Prince George	Jan. 25	1,220	6	30	187.7
Resolution	Jan. 28	1,215	7	10	169.5
Majestic	Feb. 4	1,235	6	10	200.3
Mars	Feb. 6	1,070	5	15	203.8

Up to about one hour before the coaling ceased, the *Mars* had averaged up to about 218 tons per hour, but at this point the fuel accumulated on deck, the men below being unable to trim it as rapidly as it was sent down, and though this broke her average, she for the time held the record so far as this division of the squadron was concerned. The best hourly record was 234 tons.

On board the *Prince George*, from 1:30 to 5 p. m., during daylight, 712 tons, or 203.4 tons an hour, were taken in, and the best hourly record was 212 tons. The remainder was taken in after a rest of half an hour for supper.

On board the *Majestic* the coaling began at noon and was completed just after 6 p. m., during which time 1,235 tons were taken in. The first three hours were very good, being 248 tons first, 244 tons second, and 214 tons third. The average dropped toward the end, as lighters were emptied and not all the hoists could be kept working.

In this connection it should be noticed that there were seven winches in use, which makes the hourly average per winch vary from 24.2 tons for the *Resolution* to 29.1 for the *Mars*. The best record for the *Majestic* being 248 tons in one hour, gives an average of 35.4 tons per hour per winch, that for the *Mars* being 238 tons, or 34 tons per hour per winch.

These ships carry an average complement of 44 officers (excluding the captains and commander-in-chief and staff) and each 757 men, excepting the *Resolution*, which carries 712 men.

The *Prince George* now holds the coaling record for the English navy, having on June 28, 1901, taken on board 1,206 tons at the rate of 226 tons per hour under the same conditions that prevailed when the coaling competition just described took place in January.

On July 1 and 2, 1901, three vessels of the squadron coaled simultaneously, followed by the *Resolution*. At this time the conditions were less favorable, as the facilities had to be divided up.

The *Majestic* had one collier, one Temperley vessel, and lighters, and worked from both sides at the same time. The *Mars* began with one Temperley vessel and two steam derrick lighters, but after ten hours' work the lighters were withdrawn and the work was finished from one collier. The *Hannibal* took all her coal from one collier, working from one side only. The *Resolution* had two Temperley vessels and one steam-derrick lighter.

The results attained were as follows:

Ships.	Amount taken.	Working hours.	Average tons per hour.
	Tons.		
Mars	1,435	18.00	79.7
Majestic	1,635	19.00	86.5
Resolution	1,160	12.75	91.0
Hannibal	1,782	18.00	99.0

SECTION VII.

MARINE CASUALTIES.

AUSTRIA.

Aspern.—On the morning of February 27, 1901, while at anchor off Shanghai, the cruiser *Aspern* was run into by the steamer *Macedonia*, which vessel was shifting her moorings. Her stem struck the *Aspern* forward and cut the cruiser's ram clean away, receiving considerable damage herself. The ram went to the bottom, but was subsequently recovered by divers, and both ships were docked for repairs. No person was injured on either vessel.

ENGLAND.

Benbow.—Early in the month of August, 1900, the battleship *Benbow*, one of the mobilized fleet, was in collision with a steam collier in the roadstead at Milford Haven and was so much damaged that several weeks' repairs were necessary before she could return to her station as guard ship at Greenock. There was a heavy sea running and a strong wind blowing at the time of the collision.

Centurion.—During the night of April 17, 1901, in a gale on the Yangtze, the battleship *Centurion*, lying off Wusung, dragged her anchors and fouled the ram of the battleship *Glory*, sustaining some injury. One of her water-tight compartments was pierced and flooded, so that she had to proceed to Hongkong to be docked for repairs. The *Glory* was not injured.

Conqueror.—About 9:45 a. m. on July 11, 1900, the battleship *Conqueror*, proceeding from Devonport to join the "A" fleet for the maneuvers, went ashore on the Shambles. She was floated off, however, and proceeded about 5:20 p. m. of the same day.

Devastation.—On August 28, 1900, while a number of men were practicing with a 7-pdr. muzzle-loading gun on board the battleship *Devastation* at Gibraltar, there was an explosion while they were loading the gun, and two men were injured, one very seriously and the other slightly.

Goliath.—An accident resulting in the loss of two lives occurred on board the battleship *Goliath* at Hongkong, early in August, 1900. In the torpedo-head room of the ship there was stored temporarily a quantity of stores belonging to the canteen, and a marine went into the compartment to get out some of the goods. Somewhat later a blacksmith, on going to the room, found the hatch closed, and on removing it saw the marine lying at the bottom unconscious. It is presumed that he went to the assistance of his shipmate and was himself overcome by the foul air, for both men were subsequently found unconscious and apparently dead on the floor. Assistance was promptly rendered, and one of the rescuing party was also overcome by the foul air and remained unconscious for a considerable time, but was finally resuscitated. The two men who first went into the compartment could not be restored, though every effort was made.

Hood.—As the battleship *Hood* was leaving Malta on April 18, 1901, with the Mediterranean squadron, she fouled the French steamer *Eugene Perière* which was lying at anchor. The *Hood* lost two of her boats which were smashed to pieces. The injury to the steamer was slight, though a serious disaster was only averted by a smart evolution on the part of the battleship.

Trafalgar.—A mishap, fortunately unattended by serious consequences, occurred early on the morning of July 30, 1900, in connection with the "B" fleet engaged in the naval maneuvers. The fleet at the time was about 5 miles southwest of the Chickens Rocks maneuvering without lights, when the battleship *Trafalgar* attempted to cross the bows of a passenger steamer, the *King Orry*. When collision was seen to be inevitable, the helms of both ships were put over so that the impact took place in an oblique direction. The effect of the blow was therefore minimized, but nevertheless four holes were made in the hull of the *King Orry* above the water-line and her steering gear was carried away. The vessel was, however, able to proceed to her destination.

Cressy.—Early in June, 1901, the *Cressy*, when about ready to start for the China station, sustained an injury to her steering gear which caused her considerable delay. The accident consisted in the fracture of the quadrant head, or head casting, as it is generally called. It was proposed to substitute the *Aboukir's* casting, but about six weeks would be necessary to make the change. The cause of the accident has not been disclosed.

Euryalus.—On the morning of June 11, 1901, a fire broke out in the wharf at Barrow at which the recently launched armored cruiser *Euryalus* was lying. She was drawing 19 feet 6 inches aft and 17 feet forward. The fire spread with such rapidity that before the ship could be removed from the wharf the teak sheathing on the starboard side took fire and was almost completely destroyed above the water-line from the after casemate to the stem, the plates and frames in the wake of it being much buckled, also the side plating above it, all of which was condemned by the admiralty surveyor. It was feared that the armor had been affected by the fire and cooling, but this has not as yet been ascertained.

Barham.—A telegram from Barcelona to London on June 11, 1901, states that the *Barham* touched the ground during maneuvers and that her forward compartment was full of water. It also said that the ship was in no danger and that she was anchored with the rest of the fleet. In searching for the enemy on the previous night, and trying to screen herself under the land, she ran ashore on Formentera Island. She was only slightly damaged, but was sent to Malta and docked for repairs.

Barracouta.—On the morning of November 6, 1900, a fire occurred on board the cruiser *Barracouta*, lying in Simon's Bay. Her crew had been quartered on board of a hulk while she was being refitted. At about 11:30 smoke was seen issuing from the after part of the vessel. Officers and men from the fleet proceeded on board the vessel and after working at the pumps for over an hour the fire was extinguished. It is reported that the fire originated in one of the empty magazines, but the cause of it is not known. The damage to the vessel was not serious.

Charybdis.—While the cruiser *Charybdis* was off the Sacred Rocks, Strait of Belle Isle, in coming to anchor early on the morning of August 5, 1900, a carpenter's mate was killed by the cable. The ship being enveloped in a fog, at about 6 a. m. it was decided to come to anchor as there were numerous icebergs about. The anchor was accordingly let go and the cable was paying out very rapidly and could not be checked. It was not known how much chain had run out. The carpenter's mate tried to apply the brake to the windlass, but could not control the cable, and the last link brought up and completely tore away the upper part of his legs, killing him immediately.

Diadem.—The cruiser *Diadem* was docked at Devonport on April 23, 1901, for repairs to her propeller-shaft casing, and it was found that the copper casing of her port propeller-shaft was entirely torn away. The accident occurred while the Channel Squadron was on its way from Gibraltar to Berehaven during the second week in April. When steaming through the Bay of Biscay, the captains of the *Diadem* and *Niobe* received orders to get steam for a four-hours' full-power trial. There was a race between the two sister ships and, after it had been in progress for a little over an hour and *Diadem* was maintaining a speed of 20 knots, something was felt to go wrong with the port propeller. Speed was slackened, but there was a continual bumping although the engines were working smoothly. The run to Berehaven was continued at about 7 knots, the *Niobe* also slowing down on being informed of the accident. On arriving in port, divers found that the casing was hanging on to the shaft, the excessive vibration caused by the high rate of speed having loosened the rivets. After three days' work the casing was removed, and it was found that no damage had been done excepting a piece cut out of one of the propeller blades.

Indefatigable.—The *Indefatigable* reached Bermuda about the middle of April, 1901, and was dry-docked for repairs. While entering the harbor of Port Antonio, Jamaica, she struck the bottom and carried away part of her bilge keel, besides bending in several of her frames. The channel is narrow and, it is said, incorrectly charted.

Pegasus.—On May 28, 1901, as the *Pegasus* was proceeding down the river from Chatham to Sheerness, she grounded near Port Victoria and remained fast. She was, however, towed off shortly after dark of the same day by three tugs from the dockyard and taken into Sheerness Harbor. She remained upright while aground and is said to have sustained no injury.

Sybille.—The second-class cruiser *Sybille*, of 3,400 tons, was totally wrecked on the morning of January 16, 1901, in Lambert's Bay, to the northward of Saldanha, during a heavy gale. On the night of the 15th she was lying at anchor in Lambert's Bay and was compelled by stress of weather to put to sea.

The captain and about fifty of the crew were on shore at the time. Lambert's Bay being utilized as a military base, the presence of the detachment on shore was necessitated by this circumstance. At 10 o'clock at night the *Sybille* steamed out of the bay, which affords virtually no protection to shipping and is an exceedingly bad anchorage. She safely reached the open sea, and about 2 o'clock in the morning, the weather moderating somewhat, she was put about and proceeded to steam back into the bay. The night was dark and the weather thick, and the southerly set of the current had carried the ship some 3 miles to the southward. Presumably this circumstance was unknown to those in charge of the ship, for the doomed vessel came on and struck heavily on an ugly reef to the southward of the bay, where she remained hard and fast, all efforts to back her off proving unavailing. Shortly after the vessel had struck, the cruiser *Tartar* and the transport *City of Cambridge* arrived on the scene on their way south. A furious sea was then washing over the cruiser, and the crew had taken refuge in the rigging and on the fore bridge. In the meantime the captain had gone off to the wreck in a tug, and with much difficulty a line was got on board the vessel by means of which the whole crew was eventually taken off. The ship struck at 4:30 in the morning and the whole of the ship's company was not off the ship until 2 in the afternoon. The only life lost was that of an ordinary seaman, 19 years of age, who was swept across the deck by a heavy sea and crushed to death against one of the guns. On the following day the sea had swept the wreck 200 to 300 yards farther inshore along the reef, and it was impossible to do anything to save the ship. The under part of her was completely torn to pieces on the rocks, the lower portion being completely awash, and the water inside the hull rising and falling with the tide. All hopes of saving the ship were abandoned and efforts were made to save the guns, which were successful, only one being lost. A quantity of stores was also saved. A local paper remarked on the exceptional nature of the weather at the time as follows:

> Under ordinary circumstances we should have little hesitation in venturing to predict fine weather at this time of the year, but the extraordinary violence of the recent gales and floods has puzzled the most experienced students of Cape weather.

Mutine.—On December 19, 1900, while off Plymouth on the way to Sheerness to be turned over to the Government, one of the tubes in the Belleville boilers, with which the sloop *Mutine* is fitted, burst, very seriously scalding two men who were working near the boiler. The ship was still in the hands of the contractors.

Nautilus.—On October 12, 1900, the training brig *Nautilus* was in collision with the training brig *Liberty*, in Plymouth Sound. They were returning to their moorings and the latter was moored when the former was driven upon her by the strong tide, and both vessels considerably damaged.

Onyx.—The torpedo gunboat *Onyx*, employed on fishery protection duties in the North Sea, was damaged in a collision off Lowestoft on March 25, 1901. She was lying at anchor, when a schooner which had dropped anchor in the vicinity, dragged her anchor and swung into her, damaging one torpedo tube and smashing the bows of one of her boats. She was subquently repaired at one of the dockyards.

Plover.—On March 20, 1901, the gunboat *Plover* went ashore in the Yangtze River below Kiukiang. The *Redpole* was sent to her assistance and succeeded in getting her afloat. The accident was not considered at all serious.

Research.—While the surveying vessel *Research* was lying at anchor off Dover about May 1, 1901, making current observations, she was run into by a German bark, whose captain supposed her to be under way, and considerably damaged about the bows. She proceeded to Portsmouth for repairs.

Sandpiper.—On the night of November 9, 1900, the river gunboat *Sandpiper* was sunk at Hongkong in the course of a typhoon. The destroyer *Otter* went to her assistance, and with great trouble succeeded in taking off all the crew, excepting one man who was lost. The vessel was raised on the 22d of the same month, and thoroughly cleaned and restored. She was not seriously damaged, having simply been swamped by the typhoon.

Speedwell.—This torpedo gunboat had a narrow escape from a serious accident during her trials in the English Channel early in

October, 1900. When she was steaming at low power in readiness for her full-power trial, the chief engineer detected something wrong with the starboard engine, and at once ordered steam to be shut off. An examination then disclosed the alarming fact that all 6 of the connecting bolts of the starboard engine were smashed, and that 3 of the connecting bolts of the port engine were also gone. It is surprising how the starboard engine was kept going, even at low power, with all the bolts gone, and it was fortunate that the damage was discovered when it was, for had the bolts given out with the engine working at 3,000 i. h. p., there would probably have been a terrible loss of life in the engine-room, even if the vessel herself had not foundered. At the time the discovery was made there were about 20 officers and men in the engine-room.

Elfin.—The royal yacht *Elfin* was badly damaged by a gale January 3, 1901, at Portsmouth. While going alongside a hulk to coal she was thrown by the wind against the hulk with such violence as to smash her starboard paddle box and wheel.

Cygnet.—About the middle of June, 1901, during the maneuvers of the Mediterranean squadron, the torpedo-boat destroyer *Cygnet* collided with the *Orwell.* It appears that the signal to turn eight points to starboard had been made, when the *Cygnet's* steering gear broke down. She was thus unable to turn and collided with the *Orwell*, on her port side. The bow of the *Cygnet* was completely buckled up, but the *Orwell* sustained only slight damage. Both vessels were, however, sent to Malta for repairs.

Cynthia.—On October 3, 1900, this destroyer put into Leith, with the *Mermaid*, considerably damaged. While engaged in maneuvers she ran afoul of the *Mermaid*, twisting her own bow and making a hole in the hull of the *Mermaid*, fortunately above the water-line.

Daring.—On the night of June 10, 1901, one man was killed and four others injured by the explosion of one of the bottom tubes of the Thornycroft water-tube boiler of the torpedo-boat destroyer *Daring.* When the explosion occurred the fire-room and engine-room filled with dense clouds of steam, and one of the firemen was instantly killed by the rush of steam and boiling water. The other four managed to reach the ladder to the deck, and were eventually rescued. The remainder of the crew made every effort to reach the lower parts of the vessel, but for some time this was impossible, and it was a long time after the four men had been rescued before the body of the unfortunate victim was taken from the fire-room. The four men mentioned received very serious injuries, and one of them has since died of his injuries. The *Daring* was just off Portsmouth Dockyard when the boiler burst. A fire broke out after the explosion, but it was subdued in half an hour without much damage being done to the vessel.

Dasher.—Early on the morning of April 15, 1901, the Chatham instructional flotilla of destroyers left Portsmouth for Devonport, and two hours later the *Cynthia* dropped out of her station. In recovering her position in the line it was necessary for her to pass the *Dasher*, but instead of clearing the vessel she ran into her port bow with such force as to make a hole in the plates above the water-line, while the plates below were badly strained. There was a heavy sea running at the time, and at every pitch of the *Dasher* fresh seas were shipped, so that when, on the return to Portsmouth, Swanage Bay was reached, the commanding officer, finding that he could not remain another hour afloat, put in for shelter. Assistance was sent from Portsmouth, and the vessel having been cleared of water and the damaged parts shored up, on the 17th, with a smooth sea and calm weather, she proceeded to Portsmouth at a speed of 8 knots. Then it was found that her steering gear had broken down, and she had to be towed into harbor. She was docked for temporary repairs, and then sent back to Chatham, where she was put out of commission.

The collision appears to have been due to the bad weather prevailing at the time. The *Cynthia* had stopped to secure her cables, which had been washed adrift, and while attempting to get back to her position ahead of the *Dasher* the helmsman of the latter boat was washed away from the wheel by a big sea, and she fell across the bows of her sister ship and got rammed. The *Cynthia* was also very badly damaged and had to put into Kimmeridge.

Lee.—On December 5, 1900, this destroyer, while undergoing her steam trials, grounded on Maplin Sands. She was in danger of toppling over with the falling tide, but the crew went over the side and shored her up. She was floated at high water without serious damage.

Leven.—On October 4, 1900, this destroyer sustained serious damage while making a passage from Torbay to Devonport. She had her bow twisted and several plates badly bent so that she had to be docked for repairs.

Mermaid.—See note on *Cynthia.*

Opossum.—This destroyer met with a serious accident on the night of September 7, 1900, during maneuvers in Plymouth Sound. The officer in charge of the operations was anxious to ascertain if it was possible for a destroyer to cross the ridge of rocks between Mount Edgcumbe and Drake's Island at low water, and the *Opossum* was selected for the experiment. This was done when the water was at the lowest, and the *Opossum*, steaming at over 20 knots, crossed the ridge, but struck a portion of it and badly smashed her propellers and sustained other serious injuries so that she had to be docked for repairs.

Osprey.—On March 22, 1901, while moving up the harbor at Portsmouth, the destroyer *Osprey*, in trying to avoid a collision with a steam launch laden with passengers, ran afoul of the *Research*, and sustained such severe damage that she had to be at once taken into dock. In addition to staving a large hole in her side, the force of the collision was so great that some of the machinery in the engine-room was torn out of place. Fortunately none of the steam pipes were broken, or there might have been some loss of life.

Rocket.—One day in April, 1901, a severe thunderstorm broke over Ireland Island, Bermuda, about half past 3 in the morning. The mast of the destroyer *Rocket* was struck by lightning, a large portion of the topmast being split in pieces, which came down on deck, and one of the wire topping lifts being completely fused. It has always been considered that the masts of destroyers were not high enough to attract lightning, and for that reason no conductors have been fitted to them. This accident shows that such a danger exists. Fortunately no one was injured.

Seal.—Early in April, 1901, eight boats of the instructional flotilla of destroyers returned to port more or less disabled from the heavy weather encountered. The most serious case was that of the *Seal*, the back of which was broken so that it is feared that she is unfit for further service. She was struck by an enormous wave in the Bristol Channel. The shock was so heavy that those below thought there had been a collision. Her upper deck was cracked clear across, admitting daylight to the fire room, and the side plating was split down for 18 inches. The trouble is ascribed to the unsuitability of torpedo-boat destroyers to knock about in weather that causes larger vessels to seek shelter.

Sylvia.—On December 19, 1900, the destroyer *Sylvia* returned to Portsmouth disabled, having broken her rudder while cruising with the instructional flotilla.

Thrasher.—In the course of night exercises in the harbor of Plymouth during the first week in September, 1900, the destroyer *Thrasher*, while running at a speed of 20 knots, ran upon some floating wreckage and received serious injuries. So bad a leak was caused in the fore part of the vessel that she was compelled to run to port for safety and to be repaired.

Violet.—On July 14, 1900, while engaged in maneuvers of the "B" fleet, this destroyer collided with the *Flirt* during a fog, seriously damaging her bows, and buckling a number of her side plates, which had to be removed from both sides for repairs. The *Flirt* sustained little damage.

Zebra.—Whilst rounding Garrison Point, Sheerness, on October 17, 1900, on her return from gunnery practice, this destroyer collided with the barge *Emily*, of Milton, striking her on the starboard quarter. The barge sank in ten minutes, her crew being rescued. The mate, who was ascending the ladder from the cabin when the accident occurred, had a narrow escape. The *Zebra* had her bows stove in.

No. 45.—On July 14, 1900, just after a flotilla of torpedo boats had left Plymouth Sound for the maneuvers, *No. 45* was in collision with another torpedo boat, and was so badly damaged that she had to return to harbor. Her bow was stove in and one of her compartments was flooded, but she was able to get back to harbor under her own steam without further mishap.

No. 57.—On April 14, 1901, torpedo boat *No. 57* one of the four attached to the Channel Squadron, while being backed out of the basin at Haulbowline preparatory to starting for Berehaven, struck the pier, injuring her stern plates to such an extent that she had to be placed in dock for repairs.

No. 80.—On May 15, 1901, while torpedo boat *No. 80* was proceeding into the Channel for torpedo practice she was run into by a steam hopper, which damaged her side and smashed a torpedo tube. She returned into harbor and was at once put into dry dock. She took in a considerable quantity of water, but the pumps were able to keep the water under.

FRANCE.

Amiral Baudin.—On November 23, 1900, while shifting her moorings at Brest, this battleship was in collision with the cruiser *d'Estaing*, which had just returned from Madagascar to be sold out of service, and both vessels were seriously damaged.

Amiral Duperré.—On December 14, 1900, an accident occurred on board this battleship. The squadron was engaged in target practice off Brest in a long rolling sea, when the lurching movement of the ship caused a chain of the training gear of one of the starboard turrets to carry away, with the result that the gun swung round and struck the bridge, doing considerable damage. It also struck against the backstays of the mast, carrying them away. It was reported that the mast was carried away, but this lacks confirmation. No one was injured.

St. Louis.—On the morning of October 8, 1901, during torpedo exercise, the air chamber of one of the torpedoes, launched from an above-water tube amidships on the port side, exploded at the moment of launching. The tube and spoon were completely destroyed. The after end of the torpedo remained aboard, the remainder going overboard. One man was slightly injured by a fragment of the tube. The cause of the explosion is not known.

In December, 1900, the same vessel barely escaped injury while docking at Toulon. While pumping out the dock, and while only about 12 feet of water remained therein above the blocks, some of the shores gave way, and the ship heeled strongly to starboard. The dock was immediately flooded and the ship floated without injury.

Tempête.—On the evening of June 20, 1900, this coast-defense vessel was seriously injured in the dock at Castignies. In preparation for the undocking about 8 feet of water had been let into the dock when the bilge blocks loosened and shores gave away, so that the vessel fell over in the dock, causing her to leak. A number of plates on the port side were stove, and the starboard side bent in over a length of about 60 feet, besides internal damages. The altars of the dock on which the vessel rested were crushed. Several weeks' work was necessary to repair the damages.

Amiral Charner.—While going down the Yangtze River in November, 1900, this cruiser went ashore in Round Channel, Silver Island Pass, below Chinkiang. She was floated, with assistance, and hastened to Shanghai, where she was docked for repairs.

Dupuy de Lôme.—While making the passage from Brest to Cherbourg, in January, 1901, this vessel encountered very heavy weather. Tremendous seas broke over her, and one of her largest boats was carried away.

Melpomène.—The training frigate *Melpomène* was putting into Brest on the morning of May 3, 1901, when she ran aground on the St. Marc Bank, about 330 yards south of the jetty. Several tugs went to her assistance, but could not help her because of the falling tide. She was floated off during the afternoon, however, and towed into port, where she was examined by divers. She was found to be uninjured, and proceeded on her cruise.

Vauban.—In September, 1900, it was reported that a cartridge had exploded in the forward magazine of this vessel on the evening before her arrival at Nagasaki, seriously wounding 5 men.

Caravane.—Early in the morning of October 23, 1900, this transport was run into and sunk in the Inland Sea, Japan, by a Japanese steamer, the *Yamaguchi Maru.*

She was struck almost amidships on the port side and sank in thirteen minutes. The *Yamaguchi Maru* cut into her to the extent of 25 feet, the point of impact being in a line with the bridge. The man at the wheel was killed instantly at his post. Being just after midnight (12:03 a. m.), all on board were turned in excepting the watch. When the crash came all hurried on deck, being unable to save anything beyond what they were wearing. Fortunately the *Yamaguchi Maru* was not backed out and away from the *Caravane*, and as the two vessels remained locked together the French seamen clambered up over the bows of the Japanese vessel and passed ropes down to assist the officers and the rest of their shipmates to save themselves.

Shortly after the collision the ends of the *Caravane* were felt to rise.

As they drew together the masts fell, and one of them struck and killed the captain of the *Caravane* and threw him overboard. In a few minutes the ship—now almost divided into two distinct parts—settled down and disappeared. When the crew was mustered on board the *Yamaguchi Maru* it was found that three men besides the captain were missing, and that several of those rescued had been seriously injured by the falling masts and spars. The weather was fine and clear, but a little misty at the time of the collision.

Décidée.—On September 27, 1900, when off Weihaiwei, a boiler tube of the port boiler of this gunboat exploded, causing the death of one man and so seriously injuring another that he died a fortnight later. The gunboat was able to make the port after the accident.

Fleurus.—On January 3, 1901, about 8 a. m., this torpedo gunboat was run into by a tugboat during a thick fog. She was struck well aft on the port side and had two holes 6 and 15 feet long, respectively, knocked in her side. By prompt use of collision mats and the closing of water-tight doors she was kept afloat, but had to be beached to prevent her sinking. Later she was floated and placed in dock for repairs. No lives were lost.

Kersaint.—About September 13, 1900, this cruiser was badly damaged by a typhoon while acting as guard ship in the Hohow Harbor. She dragged her anchors and went ashore on a sand bank, damaging her rudder seriously. At the same time a fire broke out through the spontaneous combustion of chemicals, which was extinguished by hard work before doing much damage. After the storm a jury rudder was fitted, the ship refloated, and taken to Saigon for repairs.

Framée.—Just after midnight of the night of August 10, 1900, this destroyer was run down and sunk by the battleship *Brennus*, causing the loss of 45 lives, only 14 of the crew being saved.

The night was clear and calm, with a full moon, making objects plainly visible. The French squadron, with the *Brennus* leading, was standing toward Gibraltar in column at 10 knots speed. All vessels had running lights set. About 11:45 p. m. of the 10th, the squadron being 65 miles southeast of Cape St. Vincent, the *Foudre* rejoined the squadron with several torpedo boats. Wishing to communicate with her, the admiral had the *Framée* called alongside in the place usually occupied by the *Hallebarde*, and she came up on the port beam at a speed of about 16 knots. She had but to keep a parallel course with the *Brennus*, and signals were already making, when, at 10 minutes after midnight, she gave a sudden sheer to starboard and dashed across the bows of the *Brennus*. The engines of the flagship were at once put astern, and the helm hard aport, but without avail. Her ram struck the *Framée* abreast the after smoke-pipe, and she rolled over to port and sank within three minutes.

Just before the collision the captain of the *Framée*, who was on the bridge, was heard to give the order, "Vingt degrés à gauche" (which seems to mean 20 degrees of starboard helm), and when she took the sheer to starboard, full speed ahead was ordered on her engines. It would appear that few of the men could swim, as those rescued are spoken of as good swimmers, and they were but a short time in the water. All of the officers of the vessel were lost with her, though they were on deck at the time of the collision.

The accident seems to have been due to the faulty system of transmitting orders, as it is said that on two former occasions, when orders were given to put the helm hard-a-starboard, it was jammed hard-a-port.

Averne.—This sea-going torpedo boat, while en route to Toulon from Brest, had one of her boilers so badly damaged that she had to be towed into Algiers for repairs.

Bouet-Willaumez.—This first-class torpedo boat, on the evening of August 31, 1900, in a fog, ran on a rock off the harbor of Cherbourg and sank in 25 fathoms of water. The crew was saved. Several attempts were made to refloat her, and on the 17th of September, by means of three chains passed under her, she was lifted part of the way, but the weather becoming threatening, the chains had to be cut, allowing her to go to the bottom again. Subsequent efforts were without success and the wreck had to be abandoned.

Cyclone.—On the afternoon of May 31, 1901, while the torpedo boat *Cyclone* was engaged in towing a target at which torpedoes were being discharged from the *St. Louis*, she was struck by one of the exercise torpedoes and somewhat damaged. The torpedo was launched from an above-water tube and directed at the target, but on striking the water it deviated strongly and made for the *Cyclone* instead. The latter increased her speed to avoid it, but without success, and was struck about amidships at the water-line and had her skin plating pierced. A collision mat was placed over the hole and she returned safely to port. The torpedo was destroyed.

Grondeur.—About the middle of March, 1901, by the rupture of a piston of this torpedo boat the engines were seriously damaged and a machinist badly injured.

Trombe.—On September 25, 1900, while this torpedo boat was making her first trials, having been but three days from the shipyard, she was to the northwest of the island of Groix, between Port Lay and Quilhuit, going at a speed of 25 knots, when it was seen that she was running straight for a rock that showed above water. The captain ordered the helm to starboard, but it was too late, or the helm did not work, for the torpedo boat struck a few seconds later on the obstacle with all her force. The shock was terrible. The bow was crushed upon itself like an accordion for the length of 18 feet, stopping at the first water-tight bulkhead. The anchor gear was also smashed. Upon receiving news of the accident three tugs were ordered to the vessel. They succeeded in floating her and bringing her into port. A boiler maker who was forward at the time was badly injured and had to be sent to a hospital. The bow was raised with big chains attached to two pontoons, and divers found that the after part had not been injured. The damage was made good at the shipyard where she was built. A report says that it was foggy at the time of the accident.

No. 91.—On March 12, 1901, while exercising at Lezardrieux, this torpedo boat struck a rock near the Isle of Brehat and sprung a leak. She ran at once for the dockyard, and while the preparations were making to put her in the dock she suddenly sank. She was afterwards raised and put on the marine railway for repairs.

No. 106.—On November 23, 1900, while exercising off Brest, this torpedo boat encountered a torpedo fired from the submarine *Narval*, and had to be run on shore to keep from foundering.

No. 178.—During the first week in September, 1900, while engaged in artillery practice off Bizerta, an explosion occurred on board of this torpedo boat. One fireman was killed and two others injured. The boat suffered no outward damage, but her engines were wrecked, and she had to be towed into port. The cause of the explosion has not been stated.

No. 245.—On February 12, 1901, while exercising near Toulon, this torpedo boat was disabled by an accident to her boilers, due to the bursting of a boiler tube. Three men were very seriously injured. The boat was only recently completed and had been in service but three months. She was towed into Toulon for repairs.

Torpedo boat.—On September 17, 1900, a telegram from Paris to a London agency said: "An explosion occurred to-day on board of a torpedo boat exercising in the Seine, near Paris. The boat sank and ten men were drowned."

GERMANY.

Kaiser Friedrich III.—On the night of April 1, 1901, the battleship *Kaiser Friedrich III*, flagship of the squadron under the command of Prince Henry, while steaming at full speed struck the bottom near the Adlergrund, to the eastward of Arcona. She passed over the obstacle, but damaged four of her water-tight compartments, which began to fill, also damaging her rudder. The doors were closed and the pumps started, while the ship was taken in tow by the *Kaiser Wilhelm II*, the engines being stopped. The hawser carried away, however, and she was able to reach Kiel under her own steam. Her liquid fuel took fire and caused more serious internal damage. She was placed out of commission for repairs, which will take several months and cost about $720,000.

The fire was caused as follows. This vessel carries a quantity of "masut," a heavy residual oil of petroleum, which is used as fuel, in her double bottoms, where, being completely shut off from all communication with the interior of the ship, it was believed to be perfectly safe. Upon striking the obstacle the inner bottom was forced up so that it leaked, and the "masut" from the double bottom found its way to the fire room, where it took fire, filling the compartments with flames, which appeared as high as the masts. After strenuous efforts, lasting three hours, the fire was subdued, but it was necessary to admit water to the fire rooms, storerooms, and magazines, and eight of the boilers were damaged. At one time it was feared that it would be necessary to abandon the ship. The walls of the flooded compartments began to bulge, owing to the pressure within, and had to be propped—an operation of much danger. Three men were seriously injured by the fire, one of them dying of his injuries a few days after the accident. She reached Kiel with a heavy list to port, owing to the four compartments being flooded.

The absence of all wood from the ship is a feature that, under the circumstances of having the lower compartments flooded with burning "masut," contributed to save the ship from total destruction.

An idea may be gained of the force of the shock sustained by the ship from the fact that a large rock which she had torn loose was found wedged in the bottom of the ship after she had been docked at Kiel.

She was temporarily caulked with wood and cement, and on April 23 left Kiel for Wilhelmshaven under her own steam for repairs.

This is the report of the accident and the injuries to the ship that was published shortly after the accident. A later report from German papers, which probably wish to minimize the damage done to the ship, is as follows:

> The injuries are not as serious as at first supposed. The forward part of the ship is uninjured. Several of the screw plates are bent. The stern has a transverse rent at the place where the rudder post enters the ship, and the shoe supporting the rudder is broken off. The outer skin shows many indentations and leaks, but the inner watertight bottom plating is uninjured except in one place. Of the larger compartments only the port after boiler-room filled with water; all the others either remained dry or could easily be kept dry with the bilge pumps. Of the engine and boiler installation only the starboard amidship and port after rooms have suffered. In the former, the oil which penetrated it burned for awhile and damaged the electrical fiittngs, the fittings of two of the cylindrical boilers, the auxiliary engines, and the steam piping. The boilers themselves are uninjured. In the port after boiler-room, which filled with water, the boilers and fittings are uninjured; only the boiler casings and the steam piping will need repairing. The cost of repairs has not been definitely determined, but will be much less than at first estimated.

It was claimed that the charts showed 7 fathoms of water at the place where the ship struck, drawing about 26 feet. Two vessels were sent to make surveys, to ascertain if possible the cause of the accident, and rocks not marked on the charts were discovered where the accident took place, with soundings of less than 5 fathoms where the charts showed 7 fathoms or more. It was also found that the lightship was lying about 2,300 feet from where it was intended to be.

This accident draws attention to a fact that may have escaped notice heretofore—the danger to vessels of having their double bottoms filled with water, such as an extra supply of fresh water for steaming purposes. Should a ship strike a rock at a compartment that is quite filled the usefulness of the double bottom is lost, as the blow is transmitted at once to the inner bottom and would doubtless rupture it should the blow be a severe one, sufficient to rupture the outer bottom.

Kaiser Wilhelm II.—On November 17, 1900, while the German squadron was returning to an anchorage at Kiel after a day of exercising, the *Kaiser Wilhelm II*, steaming in the wake of the *Kaiser Friedrich III*, made a signal that she was about to pass her. The latter stopped and the former passed to port. Apparently the order to go ahead was given too soon on board the *Kaiser Friedrich III*, for she started to move as the other passed her bow and ran her stem into her, striking the compartment containing the steering engines. The injury was slight, however, and repaired in a few days without docking. The *Kaiser Friedrich III* received slight injuries to her bow, though it was reported that a bulkhead was injured.

At the same time as the *Kaiser Friedrich III* was injured by striking rocks on the Adlergrund this vessel also touched the ground and sustained some injury to her propellers and shoe, the latter having to be replaced by a new casting.

Victoria Luise.—While running at a speed of 20.7 knots on one of her trial trips in September, 1900, this cruiser struck some wreckage or other obstacle and carried away part of the blades of her port propeller. She also sustained other injuries and had to be docked for repairs.

Bussard.—On August 6, 1900, there was an explosion in the fire room of this cruiser, caused by the blowing out of a manhole gasket. Three men were killed and three others seriously injured.

Habicht.—On September 29, 1900, this gunboat ran upon an uncharted rock in Ambas Bay and sprung a leak. One of the compartments filled with water. The attempt to stop the leak by divers was not successful. The vessel proceeded to the Kamerun River, where she was placed upon the Government railway and the leak closed. It was then found impossible to launch the ship from the railway, although two tugs were used, and as the stage of the water was unfavorable and the keelway of the railway out of repair it was necessary to build regular launching ways and cradle to get her afloat. She proceeded to Loanda for complete repairs, that being the nearest port having docking facilities.

Gneisenau.—On December 16, 1901, this school-ship was totally wrecked by being dashed on the mole of the harbor of Malaga during a storm. Forty persons lost their lives, including the captain.

The vessel had been at Malaga for two weeks, and on the day mentioned, which was Sunday, was lying outside the port, with fires out, having been engaged in target practice. At about 10 a. m., while the ship's company was being inspected, the wind began to blow with great force. Orders had already been given to get up steam, but owing to the heavy sea the vessel parted her chains and was wrecked at the entrance to the harbor. After parting the cables the ship attempted, it is reported, to enter the harbor, but, having insufficient steam, sails had to be used. The ship had to turn through sixteen points in order to head in, and as there was not enough sea room for her to turn, the ship requiring considerable, she was driven on the mole and her bottom soon torn out, so that she sank in ten minutes, leaving but her masts above water. Boats were lowered, but they soon dashed on the rocks and their occupants were drowned. Other men jumped or were washed overboard and were lost. Others took to the rigging. There were 460 on board at the time of the accident. The report of the use of sails is probably an error, as photographs of the wreck show all sails snugly furled, which would hardly have been the case had they been set at the time she struck. It is said that the captain was warned beforehand of the approach of a gale, and was advised to leave his anchorage and enter the harbor, but he did not listen to these counsels. The senior surviving officer ascribes the disaster to the failure of the anchors and engines.

V 1.—During a storm on the evening of January 7, 1901, this destroyer ran aground in Strander Bay, near Kiel, and remained. As the water soon subsided she was not in serious danger, and was floated on the 13th and taken to the dockyard. Excepting for a slight bending of the rudder, the vessel was uninjured. She was docked for repairs and examination of her bottom.

S 8.—On March 25, 1901, this destroyer rammed the steam pinnace of the school-ship *Charlotte*. The pinnace sank and one of the crew was drowned, the other eight men being rescued by boats from the war vessels in the vicinity.

S 74.—On the afternoon of April 20, 1901, during a dense fog, torpedo boat *S 74*, while on her way from Kiel to Wilhelmshaven, collided with a fishing cutter. The cutter was sunk, her crew being rescued. The torpedo boat proceeded to Wilhelmshaven apparently uninjured.

GREECE.

Nauarchos Miaulis.—On September 18, 1900, this cruiser grounded off Coopers Point, in the Delaware River, near Philadelphia, and was subsequently floated without serious injury.

ITALY.

Andrea Doria.—A cable dispatch from Rome dated June 28, 1901, stated that the Italian battleship *Andrea Doria* was ashore near Gallipoli, on the east coast of the Gulf of Taranto. No further particulars have been received in regard to the accident.

Guiseppe Garibaldi.—On July 12, 1900, while having a preliminary trial off Genoa, tubes burst in two of the boilers of this armored cruiser, causing the death of one man and seriously scalding two others.

The ship has 24 Niclausse boilers, in 8 compartments, half forward of the engines, the others abaft them. Just abaft the engines are two compartments, one on either side of the ship, containing 4 boilers each, and the rupture took place in the forward outboard boilers of each of these groups. The trial was to be a progressive one, and the forward boilers were at first used, steam being raised in the after ones. About one and one-half hours after the ship had left her anchorage, while the engines were running at about 60 revolutions, the after boilers were connected, beginning with those nearest the engines. A few minutes later the dynamo stopped, but no one attributed this circumstance to the presence of wet steam. Fifteen minutes after the last boilers had been connected an explosion took place in the port boiler mentioned above, scalding two firemen. Fortunately, the furnace doors were closed, so that the steam could only escape through the ash-pit doors, thus preventing further accidents. As soon as access to the boilers was possible, they were shut off and their fires hauled, beginning with the after ones. Twenty minutes after the first explosion a second one took place in the starboard boiler, causing the death of a coal passer. An examination showed that a tube had burst in each of the boilers. It was also seen through the furnace doors that the tubes had been bent 4 or 5 inches downward, which made it necessary to take out seven rows of tubes from each of the twelve elements, as they were all bent or injured. The cause of the accident has not been reported.

Cariddi.—At midnight on December 23, 1900, during a fog, this gunboat, stationed in the Red Sea, ran ashore 3 miles north of Massowah, in the channel at Ras Eberem. The current in the channel is very strong, and peculiar cross currents render navigation very difficult. A gale springing up at daybreak soon made it impossible to float the stranded ship. She had a hole in her bottom 40 feet long, and lay on her port side. Before abandoning the wreck her guns and stores were removed and the crew was taken off in safety. The wreck has since been sold.

No. 47.—A telegram from Taranto dated May 25, 1901, said that through an accident to the boiler tubes on board the Italian torpedo boat *No. 47* five men were injured, two being terribly burned.

JAPAN.

Katsuragi.—During the night of October 6, 1900, this cruiser went ashore at Izumitsu, off Oshima, in a fog, while making a passage from Yokohama to Sasebo. Assistance was promptly rendered, but a gale on the 9th found her still on shore, and her sides were very badly stove in. She was submerged to her rails and was at first considered a total loss. However, on November 7, 1900, she was raised and taken to Yokosuka for repairs. She is a composite vessel of 1.500 tons, built in 1885.

Tsukishima Maru.—This training ship of the Tokyo Commercial Navigation School left Muroran, Hokkaido, November 13, 1900, and has not been heard of since. She had on board a total of 121 officers, seamen, and apprentices, the last numbering 79, and it is supposed that she foundered in a typhoon on the 17th of that month near Senoumi, Suruga Bay, as some wreckage and the body of the captain were subsequently found washed ashore at that place. She is thought to have struck a rock about 20 miles from this place and gone down in 20 fathoms of water with all on board, as not a single survivor has yet been found.

Akebono.—On the afternoon of June 18, 1901, a collision took place in Tateyama Bay between the torpedo-boat destroyer *Akebono* and the new cruiser *Chihaya*. The former was engaged in torpedo practice and the latter on her trial trip. The *Chihaya* struck the *Akebono* stem on, and the shock was so great that the crew of the cruiser thought she must have been cut in two. Three men on board the *Akebono* were killed by an escape of steam and a fourth badly injured, for, though the engine-room was not actually struck, the force of the collision in its vicinity produced an explosion. No explanation of the cause of the collision has been received. The *Chihaya* was not injured.

Niji.—This new destroyer, after an eventful trip from Southampton to Japan, was completely wrecked by being driven ashore in a gale on the Shantung Promontory. Leaving Southampton February 11, 1900, she met with a slight mishap and had to put into Portsmouth for repairs. Then she burst an air pump before reaching Gibraltar. She was supplied with a new one at Malta and continued her voyage. Something went wrong with a condenser, and she had to stop for a time at Port Said. Further repairs were effected at Perim, but things continued to go wrong, and in the Indian Ocean she was twice unable to work her engines for periods of seven hours each. Next, another trouble arose in connection with a condenser. It appears that the explosion of the air pump was responsible for all the mischief, some pieces of metal having been driven among the machinery. Finally, at Singapore, the engines were completely overhauled, and thereafter the little craft was able to prosecute her voyage without further mishap, and she arrived safely at Yokosuka May 26, 1900.

During the night of July 30, 1900, while returning to Japan from her first service, she ran ashore on a sunken rock near the southeast promontory of the Shantung province, the weather being very thick and a gale blowing at the time. An officer and two men worked their way to Weihaiwei, 60 miles distant, in a sampan, and reported the accident to the authorities there. They were so exhausted from their efforts that on their arrival they had to receive medical attention. The English cruiser *Peacock* was sent at once to the scene of the wreck. Collision mats were placed in position, and one of the compartments pumped out. On August 2 an unsuccessful attempt was made to tow her off the rocks. It was hoped to be more successful the next morning, but during the night a gale came up with a heavy swell, the vessel began to bump heavily, and before morning she broke into three parts. The guns and torpedoes were saved by the crew before they left the vessel, which all did in safety. Subsequent efforts to save the vessel were without avail; so the engines were taken out and a new hull will be built for them at Yokosuka.

Oboro.—Early in October, 1900, this destroyer, while running at a high rate of speed, struck a rock in the vicinity of Kure and tore a large hole in her bottom near the keel plate. The hole was about 2 feet wide and extended from her stem to a point directly underneath her conning tower. She remained upon the rocks until assistance could be sent, when, by the aid of collision mats and her water-tight compartments, she was kept afloat and towed to Kure, where she was put in dock and repaired.

No. 29 and No. 45.—At about 11 p. m., on November 13, 1900, these torpedo boats were in collision near Oshima Island, and both were seriously damaged. They were able to keep afloat, however, and were towed to Yokosuka for repairs.

No. 35.—On the afternoon of May 6, 1901, while torpedo boat *No. 35* was engaged in torpedo practice at sea off Sasebo, her boiler suddenly exploded, and two men who were in charge of the engine were instantly killed by the escaping steam. The damage that the torpedo boat sustained was not stated in the report of the accident.

Torpedo boats.—Two collisions took place between Japanese torpedo boats during the maneuvers in June, 1900. The first was on June

16 and the boats concerned were *Nos. 40*, *42*, and *43*. On this occasion no serious injury was done.

On the 23d of June there was a collision between *No. 9* and another boat, said to be *No. 29*, as a result of which *No. 9* was sunk. According to the latest information there were no serious casualties among the personnel, though the first reports said that three men were killed and several others injured.

RUSSIA.

Imperator Nicolai I.—On May 1, 1901, while leaving the harbor of Constantinople, the steamer *Saragossa* struck the battleship *Imperator Nicolai I.* and both vessels were considerably damaged.

Sevastopol.—In August, 1900, a mishap is reported to have occurred on board of this battleship, which seems to indicate some fault of construction. The ship went to sea to try her guns, and it was discovered that the forward turret, which contains the 12-in. guns, would not turn. It was then found that the base of the turret was displaced and that some damage had occurred in the attempts to turn it. It is also stated that one of the engine cylinders was found to be cracked.

Vladimir Monomach.—In September, 1900, the armored cruiser *Vladimir Monomach* was in collision with and sank the steamer *Crown of Aragon* in the harbor of Port Arthur. A court-martial found that Prince Oukhtomsky, commanding the ship, did not use proper precautions, but that the fact that the currents at Port Arthur had not become accurately known constituted extenuating circumstances, so that he was merely censured by the court. The Russian Admiralty defrayed the expense of raising and repairing the sunken vessel, and expended a sum of $2,575 in making good the damage sustained by the cruiser.

Djigit.—On April 9, 1901, it was reported that the cruiser *Djigit* had run ashore west of Nidingen light-house, that she had been floated later without assistance, and had been able to reach Copenhagen in safety.

No. 207.—On October 2, 1900, while a flotilla of five torpedo boats was exercising off Shan-hai-kwan, *No. 207* stopped suddenly, owing to her machinery having become disabled, and *No. 204* subsequently collided with her. Part of the side of *No. 207* was stove in and her fire room began to fill with water. The leak was finally stopped, but, as a high sea was running at the time, her officers and men were transferred to *No. 206*. *No. 207* was taken in tow by a torpedo gunboat which was present, but the towline carried away and the damaged vessel sank in 16 fathoms of water several miles from the shore. *No. 204* was slightly damaged. There was no loss of life, but three men were slightly injured.

SPAIN.

Infanta Isabel.—On August 3, 1900, just as this cruiser was about to start from San Sebastian for Arachon, the crown sheet of one of the boilers collapsed, producing a crack about 24 inches long, through which a large volume of steam and water escaped, scalding horribly the four firemen who were in the fire-room, and causing the subsequent death of two of them in the hospital. The escaping steam scorched more or less seriously the hands and faces of a number of sailors and marines who were seated on the hatch. Fortunately, the pressure of steam was not more than 60 pounds, the steam from the other boilers being shut off. In spite of that, the number of victims of the accident was twenty-two.

An inspection of the boiler showed that the furnace was entirely burnt, giving ground for supposing that there was lack of water contact, owing to an excess of scale or grease.

Ponce de Leon.—On March 10, 1901, it was reported that this cruiser had been wrecked on the bar at Huelva, and that another cruiser had gone to her assistance. No further details of the wreck are known.

TURKEY.

Shehab.—While this torpedo boat was carrying out some evolutions on March 24, 1901, a steam pipe burst in the engine room. Three engineers and six firemen were scalded to death, and several were injured. One officer went mad. The disabled boat was afterwards towed into Saloniki.

II.

NOTES ON ORDNANCE AND ARMOR.

By Lieutenant THOMAS SNOWDEN, United States Navy,
Staff Intelligence Officer.

SECTION I.

GUNS AND MOUNTS.

Opinion abroad is tending to the reduction in the number of calibers.

It is the belief that too many calibers, too close together, exist. This idea has been especially agitated in France, but has also been expressed in England.

The multiplication of calibers makes it difficult in war times to efficiently supply the many classes of ammunition with their multitude of accessories.

It is also recommended in this connection that not more than three classes of guns be allowed on any vessel, and that these be uniform for the same class as far as possible.

The British advances in ordnance include new 12-in. wire-wound guns of greater length than the old guns. These guns are being delivered and mounted in the *Formidable* class of battle ships. The new 9.2-in. guns are being mounted in the *Cressy* class of armored cruisers. This gun is to be the heaviest weapon carried by the twenty new armored cruisers of this class; two to be mounted on each vessel.

The 7.5-in. rapid-fire gun has been successfully tried and approved.

The Welin breech-screw has been adopted for the 5-in. R. F. gun.

The old 5-in. and 6-in. guns are being converted into rapid firers.

The efforts of the British are being exercised toward a large reserve of guns and ammunition.

The Maxim .303-in. machine gun is replacing all machine guns of old pattern.

New mounts for the 9.2-in. and for the 7.5-in. Vickers guns have been constructed and were shown at the Paris Exposition.

The barbette mounting for the 9.2-in. gun comprises the following parts: (1) Turntable, ammunition trunk, roller paths, rollers, etc. (2) Training gear. (3) The gun mounting, including the elevating and sighting gear. (4) Ammunition-hoisting gear. (5) The gun shield.

The turntable is built up of steel plates and angles, and is arranged to rotate on a live roller ring, for which suitable upper and lower paths are provided. The rollers are provided with flanges on both sides to take the horizontal thrust, and they are bound together by a ring to which the roller axles are secured.

The training rack is attached to the lower path, to which is geared the pinion for training the turntable. The teeth are machined out. The turntable is arranged to be rotated both by hydraulic and hand power. The gearing is so arranged that the hand and hydraulic power can not both be in operation at the same time.

Handles for hand working are provided in a convenient position on the gun platform; they are connected to the training shafts with suitable gearing. The power training is controlled from the sighting station.

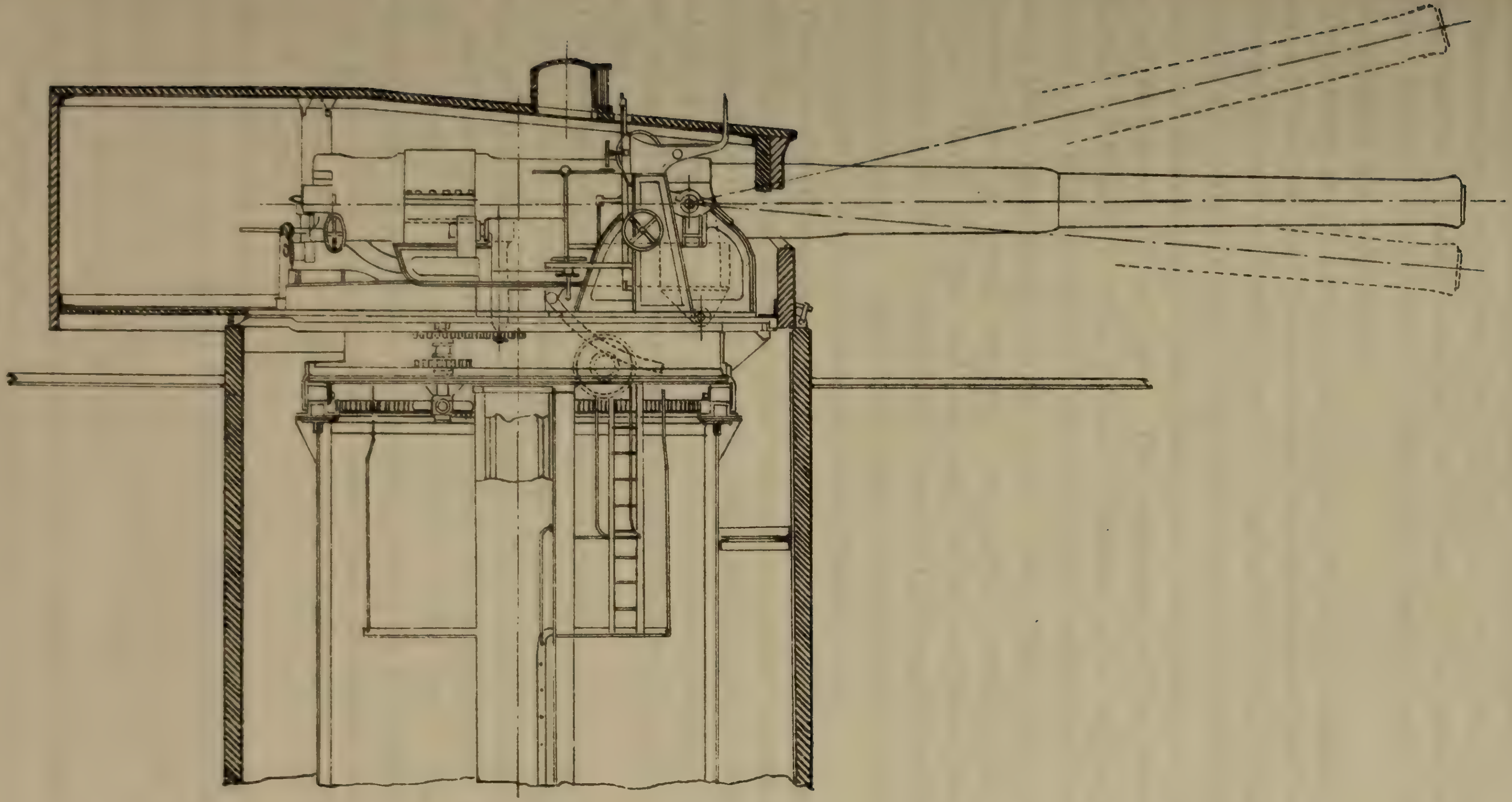
The gun is mounted on a slide frame, built up of steel plates and angles, and provided at its front and rear with bearings upon which the gun slides during recoil.

The slide is furnished at its front with two trunnion arms arranged to be supported on bearings on suitable brackets secured to the upper part of the turntable. Two recoil cylinders are attached to the rear of the slide frame, provided with pistons and rods, the latter being attached to a band on the gun with suitable projections for taking the same. The pistons are provided with orifices to allow the liquid in the cylinders to pass from one side to the other during recoil. The orifices are controlled by suitably shaped bars, so that the pressure on firing will be approximately constant.

The gun is held in the firing position by two rows of springs placed inside the slide frame. These springs are of sufficient power to run the gun out at all angles of fire, suitable arrangements being fitted in the recoil cylinders to prevent shock when returning after firing at depression or low angles of elevation.

The gun is arranged to be elevated by hand and also by hydraulic power. The elevating is controlled from the sighting station and from a secondary hand wheel on the gun platform. The sighting gear as shown is automatic and is worked by gearing from the cradle.

The projectiles and powder charges are transferred from the ammunition chambers in the interior of the ship to the gun platform by means of two hoists supported on a trunk below the gun platform and arranged to deliver the projectiles at one side of the gun and the powder charges at the opposite side; they are operated by hydraulic and hand power. A loading arm is attached to the gun slide which supports a tray on which the projectiles are placed for loading; the mechanism of the loading apparatus is such that the projectile always remains parallel to the axis of the gun, when the tray with shell is swung into the breech of the gun.



Barbette Mounting for the Vickers-Maxim 9.2-inch B. L. Gun.

A small hand winch is provided for transferring the projectiles to the loading tray from the shell trough on the turntable.

The mounting is inclosed by a shield attached to the upper floor of the turntable by suitable angles and plates. The shield is provided with a sighting hood, and is fitted with a leather apron with screws and brackets for adjustment.

The breech mechanism for the 9.2-in. gun is of the same type as that for the 12-in. gun, and is so arranged that the whole of the breech action is operated and controlled by the rotation of a hand wheel, and is suitable for either right or left hand guns. By turning the hand wheel, the breech plug is first rotated and unlocked, and then swung out of the breech of the gun. The unlocking of the breech plug is effected by means of what is usually known as a toggle joint. The long arm or link has one end fitted on a pin projecting from the rear face of the breech plug, and the other end is fitted by a pivot joint to a shorter arm or crank mounted on a pivot parallel with the axis of the gun. Both the link and the crank work in a plane parallel to the face of the breech. Around the boss of the crank are formed skew gear teeth, engaging with similar teeth formed partly around the boss of a quadrant, which is mounted on a vertical pivot.

This quadrant has also formed partly around the boss ordinary spur teeth, which engage with similar teeth on a second quadrant fixed on the hinge-bolt of the carrier. The hinge-bolt, together with its quadrant, is revolved by means of a worm and a worm wheel, which are in turn actuated by the hand-wheel suitably mounted at the breech of the gun.

To open the breech, the hand wheel is rotated, and thus, by means of the worm-wheel, the second quadrant causes the first quadrant and crank to turn, thus rotating the breech plug until it becomes unlocked. By continual turning of the hand-wheel, the carrier with the breech-plug is swung out clear of the breech of the gun. The ordinary retaining catch is employed for holding the plug in position when out of the gun. The opposite action takes place on closing the breech.

The breech plug is of the same special construction as that of the 6-in. R. F. gun.

The gun is arranged to be fired by electric or percussion tubes. For this purpose, a nut is fitted on the end of the obturating bolt; in this nut a vertical slide, which covers the end of the firing primer, is worked by means of a spring bolt which engages with a sliding bar working in the face of the carrier.

The sliding bar is also provided with a spring bolt which engages with a cam on the crank of the toggle joint. An ejector, actuated by the movement of the slide, is fitted in the nut. A spring retaining-catch is fitted in the obturating bolt, having a lip which prevents the tube from being jerked out, however violently the mechanism may be closed.

The action is as follows: When the hand-wheel of the breech mechanism is turned to open the breech, the crank begins to move, and by means of the cam it forces the slide in the nut away from the primer. When the slide has been moved down far enough, it actuates the ejector, thus jerking out the firing tube. Previous to ejecting the tube, the retaining catch is automatically lifted by the ejector so as to allow a free passage. On the first movement of the slide downward and before the breech has been unlocked, the firing needle is automatically cocked by means of the toe with which it is provided engaging with a quick incline on the rear of the firing gear nut. The spring bolts are arranged so that in the case of a miss fire the slide may be pulled down by hand to a certain extent, sufficient to eject the tube without its being necessary to open the breech.

The greater part of this movement is identical in the 9.2-in. and 7.5-in. breech fittings. The shield or barbette is intended to give complete protection to the breech of the gun, the mechanism, and the crew. It weighs 50 tons, the gun 28 tons, while the entire revolving weight of the mounting is 120 tons.

The barbette is balanced at its center of gravity and revolves easily.

The barbette armor in front is 6¼ inches thick, and 4 inches at the side. The gun can be loaded between 4 degrees depression and 6 degrees elevation, the maximum elevation of the gun being 15 degrees, and depression 7½ degrees. The full traverse of the gun through 270 degrees is carried out in 20 seconds by power, while by hand 4 men can perform the same in 70 seconds.

The Vickers-Maxim special new mechanism has been lately adapted to these guns for opening and closing the breech by a single movement of a hand lever, requiring 2 seconds. By this improvement 5 rounds were fired in 1 minute, 26½ seconds, or 3½ rounds per minute.

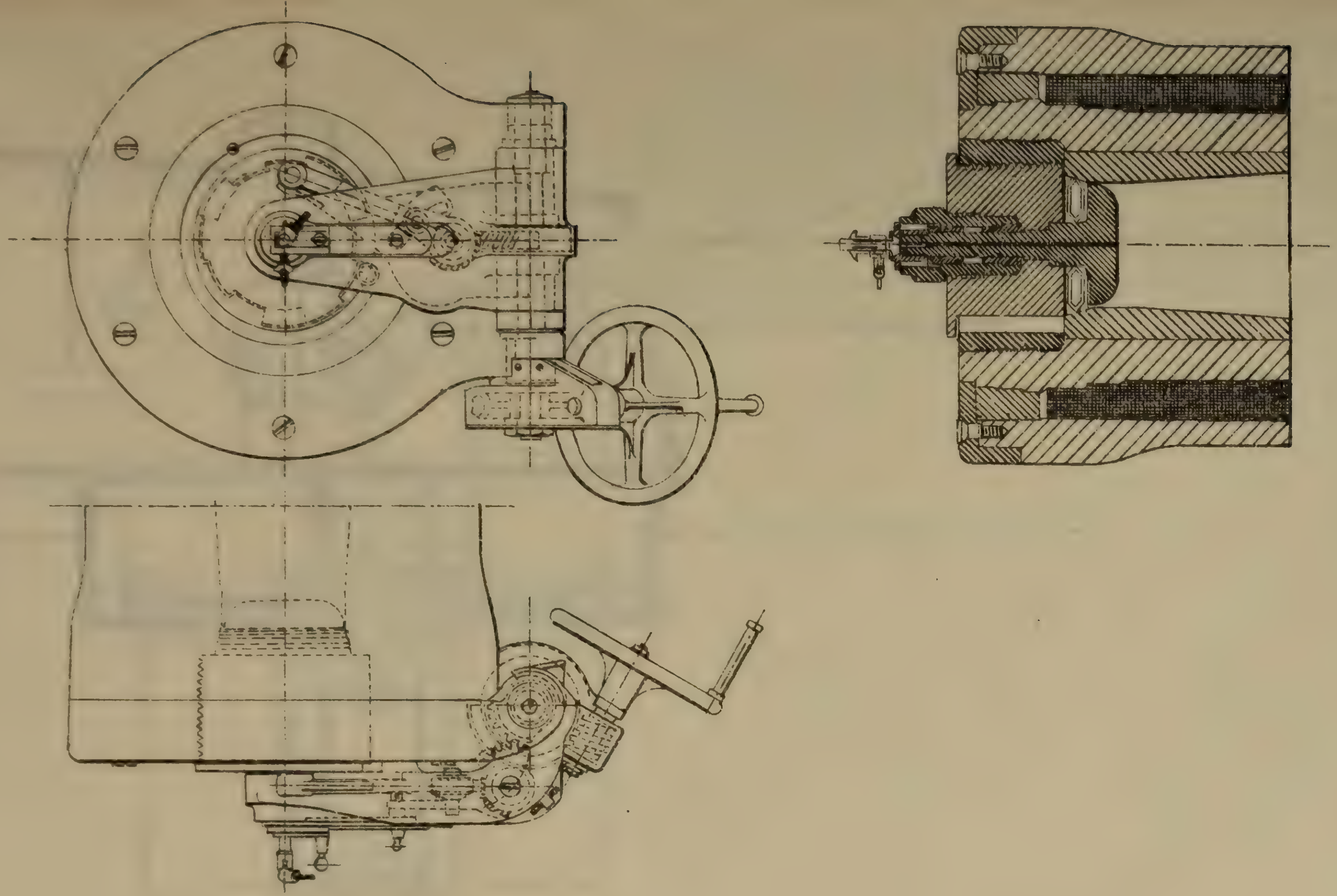
In ships, as the *Centurion* and *Barfleur*, having this type of gun, the best rate heretofore has been 1 round in 1 minute, 30 seconds.

This improvement, therefore, shows a rate of fire of 5 times over the old type.

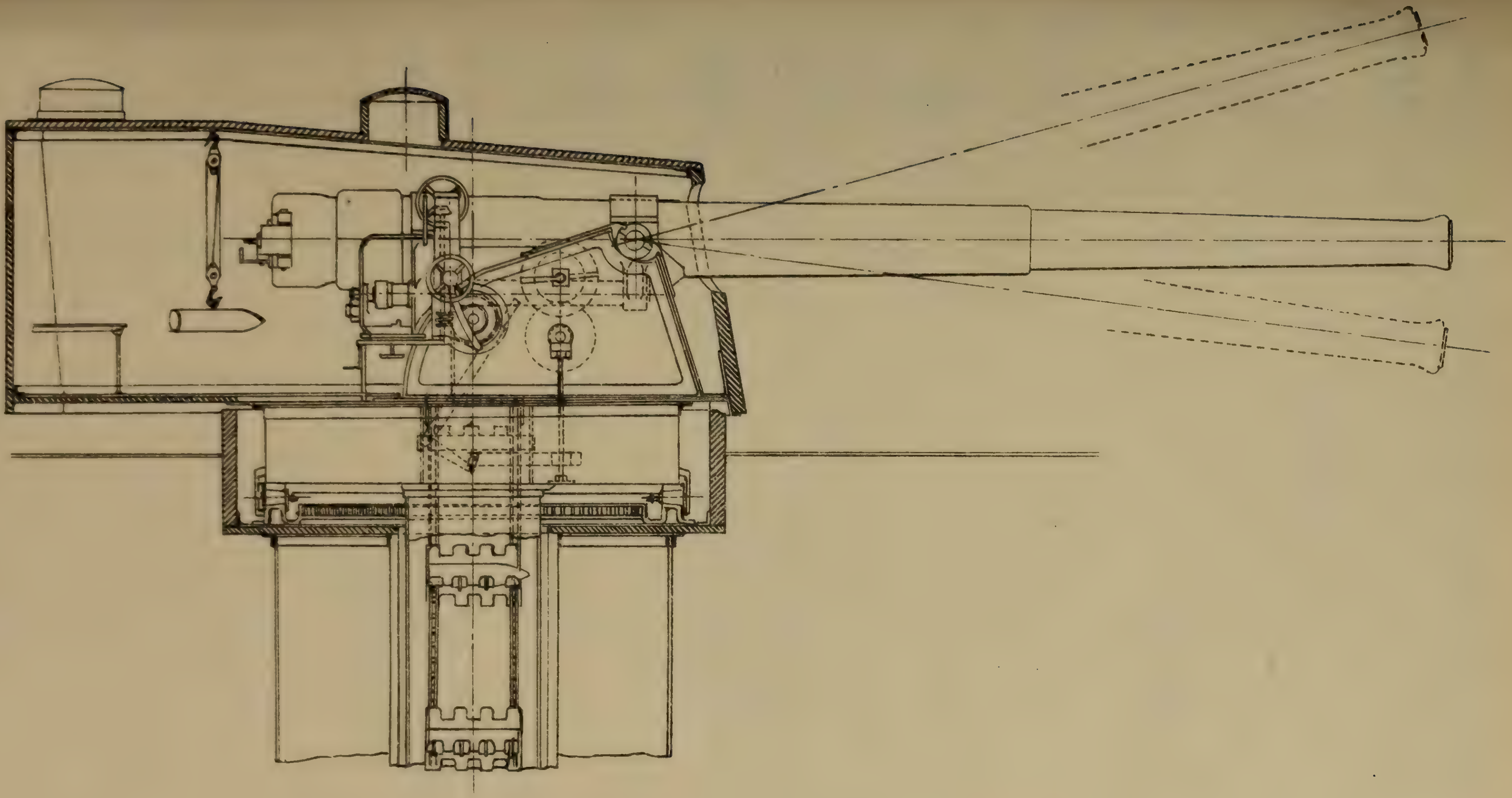
DESCRIPTION OF THE NEW VICKERS-MAXIM 7.5-IN. QUICK-FIRING GUN.

[From the *Journal of the Royal United Service Institution.*]

The gun is of steel and wire construction. It is 50 calibers long in the bore, the total length from the breech face to the muzzle being 386.7 inches. It is constructed with an outer tube extending the whole length of the gun, into which a tapered liner is driven and held in position by a bush screwed into the breech end of the gun, and in this the breech plug of the mechanism is screwed. Wire is tightly wound round the outer tube, the tension varying in successive layers, according to the method usual in the manufacture of these guns.



Breech Mechanism for the Vickers-Maxim 9.2-inch gun.

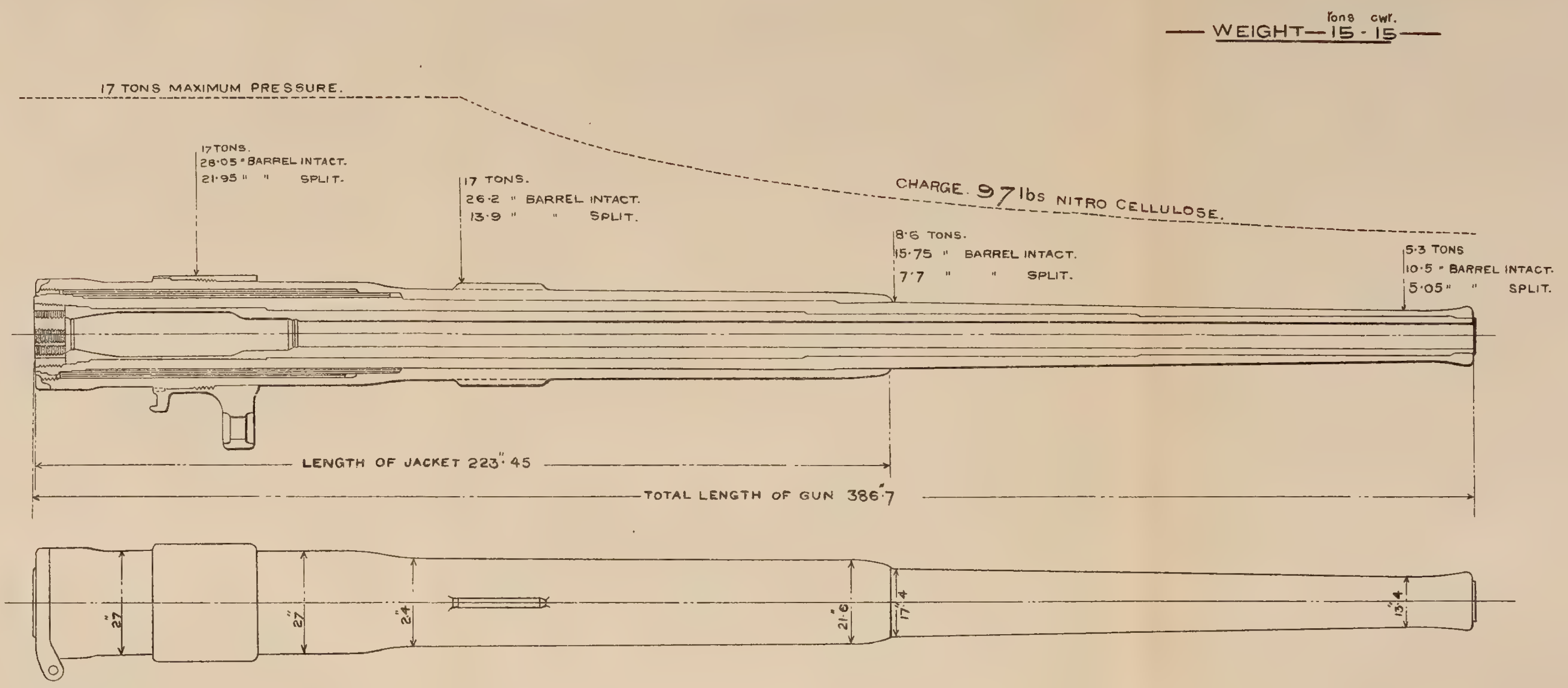


Barbette Mounting for the Vickers-Maxim 7.5-inch B. L. Gun.

FROM JOURNAL R. U. S. INSTITUTION.

VICKERS-MAXIM B. L. 7.5 INCH. 50 CALIBRES.

Scale 1/40th.


WEIGHT — 15 - 15 tons cwt.
17 TONS MAXIMUM PRESSURE.
17 TONS. 28·05 " BARREL INTACT. 21·95 " " SPLIT.
17 TONS. 26·2 " BARREL INTACT. 13·9 " " SPLIT.
CHARGE. 97 lbs NITRO CELLULOSE.
8·6 TONS. 15·75 " BARREL INTACT. 7·7 " " SPLIT.
5·3 TONS 10·5 " BARREL INTACT. 5·05 " " SPLIT.
LENGTH OF JACKET 223"·45
TOTAL LENGTH OF GUN 386"·7
27"
27"
24"
21·6"
17·4"
13·4"

CHARGE. (NITRO CELLULOSE)	79 lbs
PROJECTILE.	200
VELOCITY. (FEET PER SECOND).	3000
ENERGY (FOOT TONS).	12480

The wire extends over the chamber and that portion of the bore where the highest pressures are experienced. The wire is then covered by a steel jacket, on which are formed two keys which prevent the rotation of the gun, due to the reaction as the shell is turning in the rifled bore. The jacket is connected to the outer tube by a shoulder and a screwed collar with shoulders. On the jacket is screwed a ring provided with arms for connecting the recoil cylinder.

The chamber of this gun is made exceptionally large and is designed to stand erosion caused by the employment of large cordite charges.

The chief advantages of this design of gun are:

That the gun only consists of four distinct parts, including the breech ring, and that the great thickness of the outer tube, which extends the whole length of the gun, insures great girder strength, and the tendency to bend that some designs of guns have shown is entirely obviated.

With 92.6 pounds of nitro-cellulose for a charge and using a 200-pound shot, a muzzle velocity of 2,920 feet per second and a muzzle energy of 11,825 foot-tons can be obtained.

DESCRIPTION OF BREECH MECHANISM.

Hand-lever type.—The breech mechanism heretofore referred to for the 7.5-in. gun is a new design of single-motion type, i. e., the breech is opened or closed by the single motion of a hand lever. In this design of breech mechanism, the horizontal swing of the hand-lever rotates (locks or unlocks) the breech plug, swings it in or out of the gun, and cocks the firing striker.

The firing gear is arranged for firing by electricity or percussion, and is directly operated by the hand lever, so that the gun is absolutely safe before the breech commences to open. The breech plug is of special design and is mounted and free to turn on an arm or carrier pivoted at the right side of the breech.

The threaded portion of the breech plug is divided into segmental portions of varying radii. In the 7.5-in. breech plug there are nine segments, and six of these are threaded, i. e., two-thirds of the circumference is used for resisting the strains when firing; this enables a very short breech plug to be employed. Owing to the shortness of the breech plug, it can be swung clear of the breech after unlocking without any curvature and without unusual longitudinal withdrawal.

The De Bange obturator is employed. The arrangement for actuating the breech plug is very simple, and consists of a link, one end of which is pivoted on a pin projecting from the end of the breech plug, the other end being pivoted to a short crank which is mounted on the breech-plug carrier. Around the boss of the hand lever which is pivoted on the carrier is a skew gear wheel which gears with skew teeth formed on the boss of the short crank.

The hand lever lies close up to the gun, and the centers of the link and crank are arranged to form a locking point when the breech is closed. This arrangement of link and crank provides great power, when opening or closing the breech.

The firing gear is arranged to fire either by electricity or percussion. For this purpose a nut is fitted on the end of the obturating bolt. In this nut a vertical slide, which covers the end of the firing primer is worked by means of two spring bolts. One of these bolts engages with a cam on the hand lever, the other in a groove in the link of the breech mechanism. An ejector, actuated by the movement of the slide, is fitted in the nut. A spring retaining catch is fitted in the obturator bolt, having a lip, which prevents the tube from being jerked out, however violently the mechanism may be closed.

The action is as follows: When the lever on the breech mechanism is swung away from the gun by means of the cam, it forces the slide downward in the nut. As the lever continues to swing away from the gun, it eventually loses its connection with the spring bolt of the slide, and the downward movement of the slide is continued by the movement of the link, which actuates the other spring bolt and keeps the slide in the correct relative position until the breech is closed. When the slide has been moved down far enough it actuates the ejector, thus jerking out the firing tube.

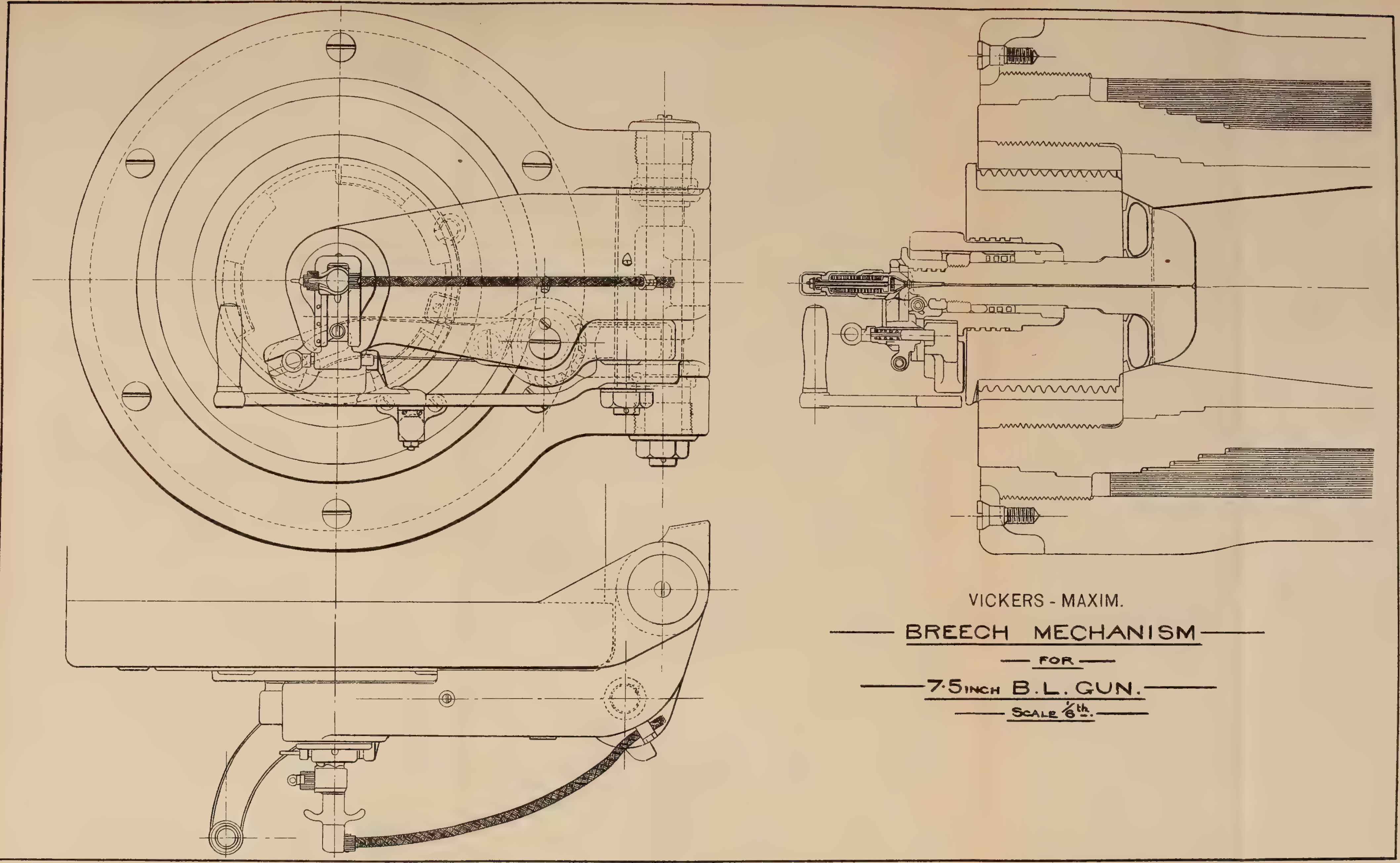
Previous to ejecting the tube the retaining catch is automatically lifted by the ejector so as to allow a free passage. On the first movement of the slide downward, and before the breech has been unlocked, the firing needle is automatically cocked by means of the toe with which it is provided engaging with a quick incline on the rear of the firing-gear nut. The spring bolts are arranged so that in case of miss-fire the slide may be pulled down by hand to a certain extent, sufficient to eject the tube without its being necessary to open the breech.

Barbette mount for 7.5-in. rapid-fire gun.—In addition to the center-pivot mounting for this gun, described in No. XIX of this series, a barbette mount has been designed. The mounting comprises the following principal parts: (1) The rotating turntable or gun platform, carrying the brackets for supporting the gun mounting, with roller paths and rollers, etc.; (2) the training gear, electric and hand; (3) the gun mounting, including the elevating and sighting gear; (4) ammunition-hoisting gear; (5) the gun shield.

The turntable is built up of steel plates and angles, and is arranged to rotate on a live roller ring, for which suitable upper and lower paths are provided.

The rollers are provided with flanges on both sides to take the horizontal thrust, and they are bound together by a ring to which the roller axles are secured.

FROM JOURNAL R. U. S. INSTITUTION.



VICKERS - MAXIM.

BREECH MECHANISM

FOR

7·5 INCH B.L. GUN.

SCALE $\frac{1}{8}$th.

The training rack is attached to the lower path, to which is geared the pinion for training the turntable.

The turntable is arranged to be rotated both by hand and electric power. The gearing is so arranged that only one form of power can be in operation at the same time. An automatic brake is also provided which is always in action, when the electric motor is not actually at work. The training motion is controlled from the sighting hood. Handles are provided for men at each side of the gun; they are connected to the training shaft with suitable gearing.

The gun is supported in a cradle with bearing straps, along which the gun moves on recoil. The forward end of the cradle is provided with trunnions arranged to rest on brackets secured to the upper part of the turntable.

The elevating arc is securely attached to the gun cradle at one side. A pinion on a transverse shaft, supported on the trunnion bracket, is provided for actuating the arc, and is operated by worm gearing from the sighting station and from a secondary handwheel on the gun platform.

The recoil cylinder is securely attached to the rear end of the gun cradle below the gun, and is provided with a piston rod attached to the lug in the gun; an orifice on the piston is provided for the passage of fluid from one end to the other, when the gun recoils after fire.

Two recuperator springs are provided, one on each side of the recoil cylinder, of sufficient power to insure the gun running out at all angles of fire. A control bar with automatic valve is provided in the recoil cylinder to insure the gun running out without shock after firing at depression or low angles of elevation.

Automatic sighting gear is provided on the gun mounting.

The projectiles and powder charges are transferred from the ammunition chambers in the interior of the ship to the gun platform by means of an endless chain hoist, provided with suitable receptacles which deliver the charges on an inclined tray at the side of the gun, from which position they are conveyed to the gun truck by hand. The hoist is driven by an electric motor, and portable handles are provided for hand working.

The mounting is inclosed by a shield attached to the upper floor of the turntable by suitable angles and plates.

The shield is provided with sighting hoods, and is fitted with a leather apron, with screws and brackets for adjustment.

TWIN MOUNTS.

Recent publications state that the Elswick firm has produced a twin mount for their 6-in. R. F. guns. The guns are mounted in pairs, resting in twin cradles side by side, so arranged as to be elevated together or separately, as desired. Each cradle is supported by a pair of trunnions, the four trunnions being in the same straight line. The two cradles can be coupled together so that the guns can be elevated and sighted as a single gun, or they may be uncoupled and each gun elevated and sighted independently. Each cradle is fitted with the usual elevating and sighting gear for working the guns, and either or both may be used. The cradles are coupled together by a longitudinal keyway cut in the adjacent sides of each cradle, which are close together, so that when the cradles are adjusted to bring the axes of the two guns into the same horizontal plane, a key can be inserted in these two keyways and so lock the cradles together, preventing one being elevated without the other. The top edges of the adjacent sides of each cradle are also grooved longitudinally, and a keep or keeps, with projections to fit these grooves, is bolted to the longitudinal key, the object of the keep being to maintain the axes of the two guns strictly parallel with each other, and also to clamp the longitudinal key securely in place. There is also a Schneider twin mount for their 5.9-in. R. F. guns, as exhibited at the Paris Exhibition. (See plates.) The following are the characteristics of the gun, as published in the *Engineering*, of London:

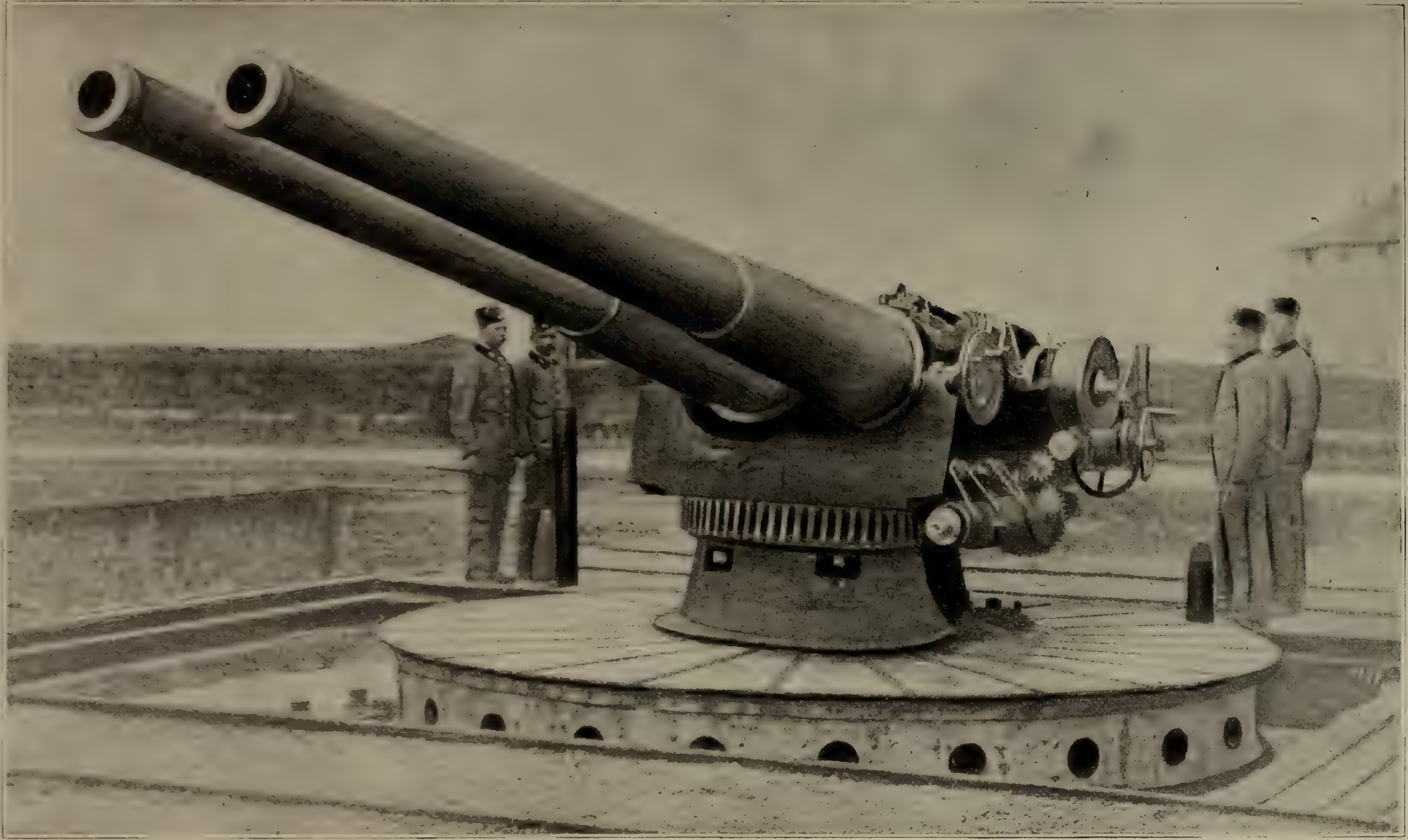
Weight of gun	pounds	10,358
Length in calibers		42
Weight of projectile	pounds	88
Weight of smokeless powder charge	do	24
Muzzle velocity	foot-seconds	2,427
Muzzle energy	foot-tons	3,730
Perforation of wrought iron	inches	20.079
Weight of mounting	pounds	16,530

In both guns the breech opens in one action of the breechblock, the latter containing safety devices against premature or hanging fire, and accidental opening of the breechblock. An extractor automatically withdraws the cartridge case when the breechblock is completely opened out.

The two guns are placed in one single jacket, fitted with four hydraulic recoil-cylinders and the two independent air-recuperators, which insure running out again under all angles. The two guns can be fired simultaneously or successively; in either case one gunner suffices for the service.

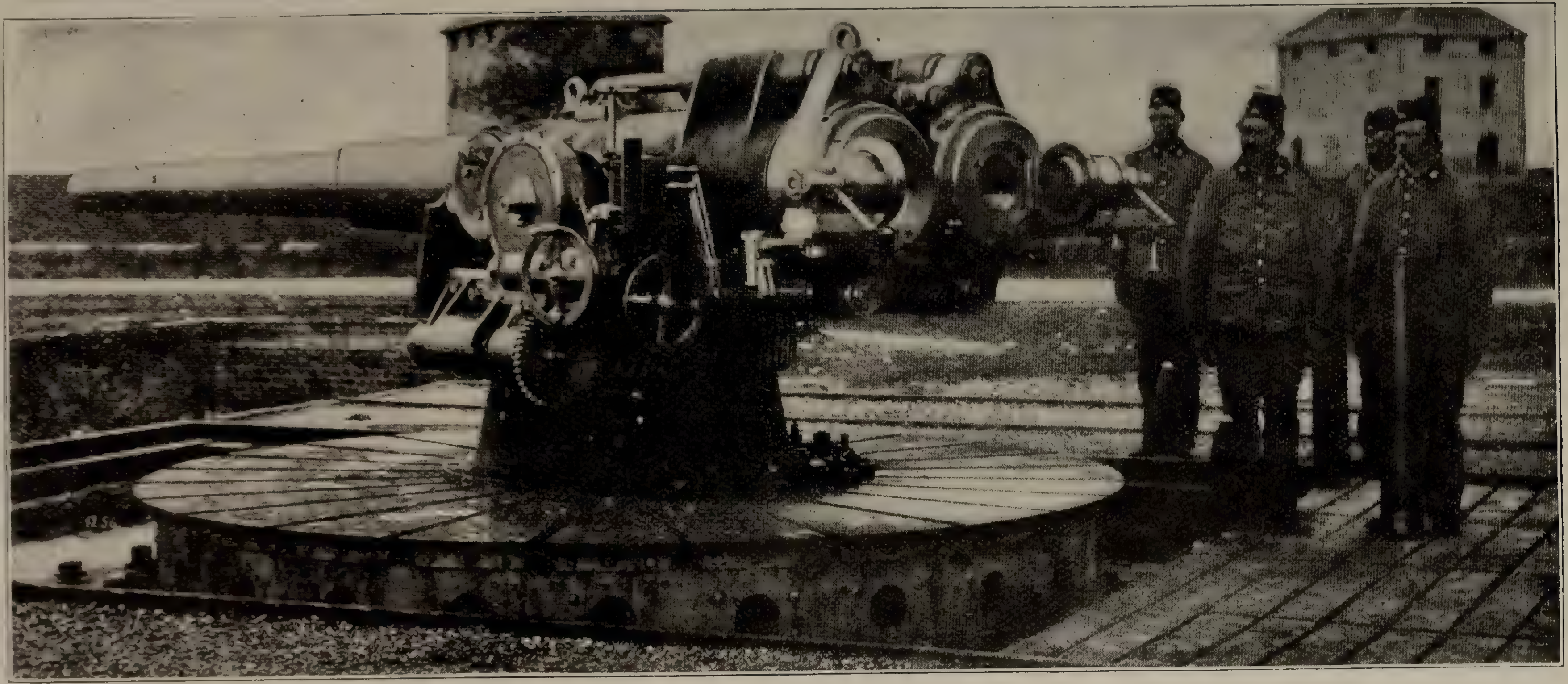
Sets of cylindrical rollers are placed between the trunnions of the jacket mounting of the trunnion plates of the slide in order to reduce the efforts required for elevating the gun. The elevating mechanism consists of an endless screw with helicoidal wheel, which insures the absolute irreversibility of the system; the action is transmitted to the mechanism by a hand wheel held by the gunner.

The movable system for lateral training is guided at the top by a series of cylindrical rollers and rests on a ring of balls, the lower racer being fixed in the bedplate.



TWIN MOUNTING FOR THE SCHNEIDER-CANET 5.9-INCH R. F. GUN.

Front view.



TWIN MOUNTING FOR THE SCHNEIDER-CANET 5.9-INCH R. F. GUN.

Side view.

With this arrangement, one man, by working the crank, can follow a target moving at a 35-knot speed at a distance of 550 yards. When the hand wheel is released, after having been turned rapidly, the movable system tends to continue its motion, but is quickly held fast by a special friction device. A small hydraulic brake and a spring buffer allow the firing of one gun only, the mounting deviating but little. The gun and men are protected by a shield fixed to the slide by elastic couplings, the shape of the shield varying at will. The principal advantages of this material are the following:

The placing of two guns in one jacket mounting reduces to a minimum the distance between the axes of the guns and also, to a large degree (compared with the guns joined together in the usual way), the couple of forces which act on the lateral training mechanism when only one gun is fired. The mountings and shield are, besides, lighter in weight.

Complete solidarity of the two guns as regards training, which can be effected by one man who has within easy reach all the mechanism enabling him to follow with both guns the displacements of a movable target. Firing is rapidly regulated and all maneuvers are most easily carried out, owing to the special measures taken to reduce all resistances. A lesser number of attendants is required for serving the two guns. Concentrated firing is easy, resulting in double the effects, at least, to be obtained with a single gun, owing to the greater concussion due to the simultaneous delivery of two shots on the target.

Service publications state that the German navy proposes to increase their turret guns from the 9.45-in. to 11-in.

They have had slow-firing guns of 10.2, 11, and 12-in. caliber on several of their older battleships and armored cruisers, but at the time of the Spanish-American war they believed that the 9.45-in. rapid-fire gun should be their largest caliber, and their newer battleships have each two 9.45-in. in each of their armored turrets and two guns of the same caliber on each of their armored cruisers.

The change in opinion is said to be because of their having succeeded in adapting their rapid-fire mechanism to the 11-in. caliber.

The new battleships and armored cruisers of this year's program are to be armed with the 11-in. rapid-fire guns.

The manipulation of the Krupp guns has been criticised abroad, in view of the complication of powers, it being considered that one kind of power should, if possible, be employed, for security in time of battle.

The English Vickers use hydraulic, but the Krupps are reported to use electric motors for elevating and training, hydraulic power for the rammer and for the recoil cylinders, a portion of the liquid being used for compressing air, storing up a part of the energy to be afterwards used in running the gun out to the firing position. This system necessitates laying the gun to a fixed angle for loading. Electrical power is also used for working the ammunition-supply motors, which have hand power also.

The Krupp modified Welin screw is shown in the plate. As described in the *International Review*, the inclined faces of the screw threads are suppressed, but the general form remains unaltered. There are eight equal sections. The system of rising steps, by which the plain unthreaded surface of the interrupted screw is reduced, is applied to the four sectors forming half the circle, and again to the other four. The first figure on the plate shows the breech open; the second, closed; and the third, locked. A rotation of 45 degrees to the right serves to engage the breech-screw bearings completely. As is pointed out, six-eighths of the circumference has a screw-thread support, instead of only one-half, as in the interrupted screw. While the face of the thread is not inclined the entire screw is conical, as shown, to enable it to be swung open and closed on a smaller circle. The breech screw is held in the shutter or carried by a bayonet-joint arrangement. When the breech is closed the bolt E, with spring G, which is fixed in the shutter, prevents rotation. The lever D, by which the breech plug is rotated, acts on the screw, pivoting on the vertical bolt K, and fixed in the shutter or carrier. When the lever closes home it is locked by a spring catch, which has to be freed to open the breech, which is done by much the same action as usual, although the extractor O, in figures 1 and 3, drawing out the metallic cartridge, is claimed to be superior to those of other systems. The adoption of the Welin screw by the Krupps, though in a modified form, is strong evidence of its efficiency for modern guns.

The plate shows the system of gun-firing circuits as employed in the English ships of the *Majestic* class. The London *Electrical Review* describes this system as follows:

> The advantages that are obtained by using electricity for firing guns in the navy are twofold. First and foremost is the increased safety; for with its electric circuit broken until the gun is run out, a gun can only be fired in a safe position, and the fuse, or tube as it is called, containing no fulminate of mercury, allows of rough handling of the cartridge, which under the circumstances that attend a rapid and continual fire is inevitable, or practically so. The second advantage is in the position of the captain of the gun, who can keep his eye along the sights and his finger on the trigger the whole time the gun is being loaded, so that he is ready to lose no time directly the gun is out again.
>
> In percussion firing, which is always an alternative in case of the electric circuit failing, the lanyard that releases the striker is not in the hands of the captain of the gun himself; it is pulled by a subordinate on the word "Fire!" When the movement of the ship is considered, together with the motion of the target, the fraction of time that elapses between the word of command and its execution makes no small difference to the practice.
>
> A reference to the plate will show how the circuit is arranged in the 6-in. rapid-fire gun. The sights are fixed on the mounting, and not on the gun itself, which by its recoil would otherwise force the captain of the gun to take a fresh alignment for

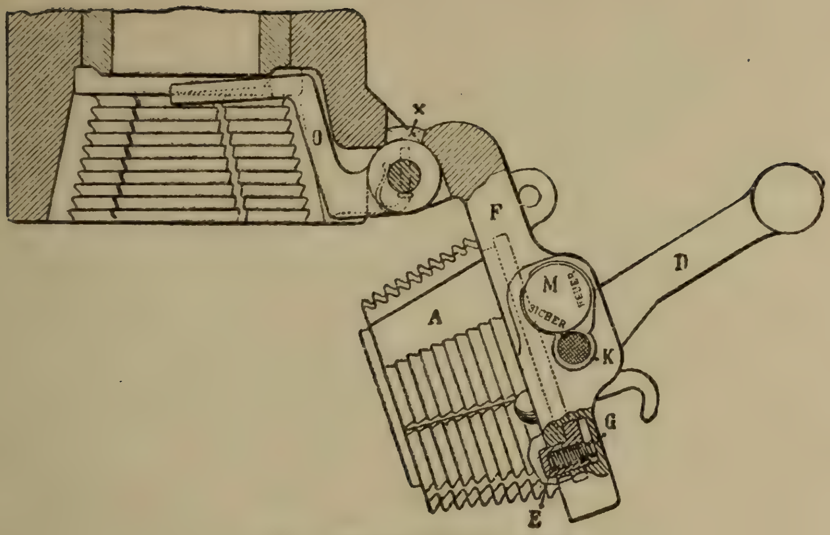


Fig. 1—WELIN BREECH OPEN

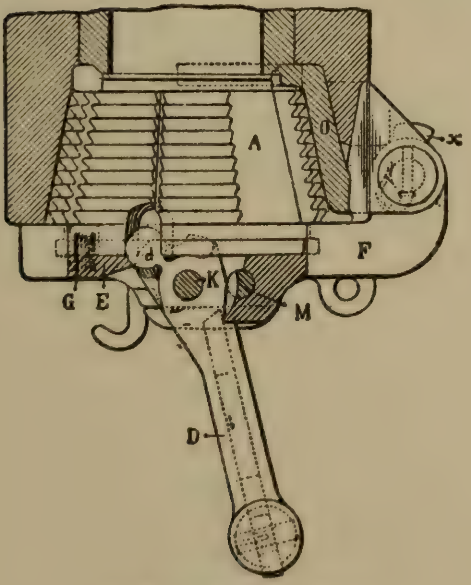


Fig. 2—BREECH CLOSED

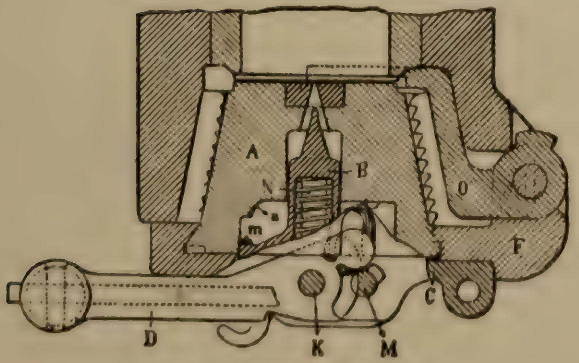
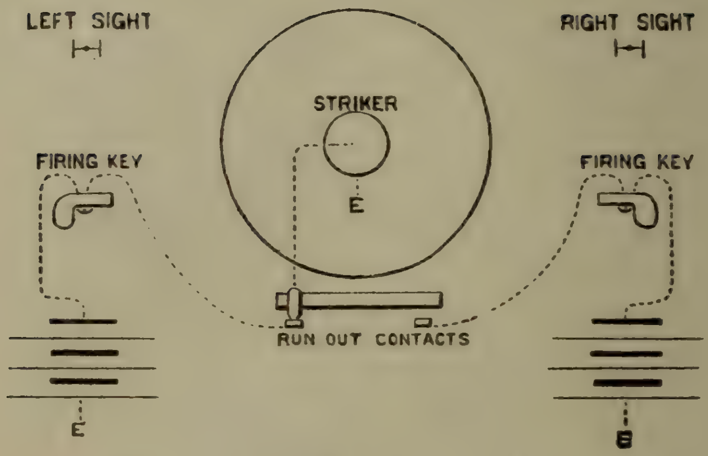
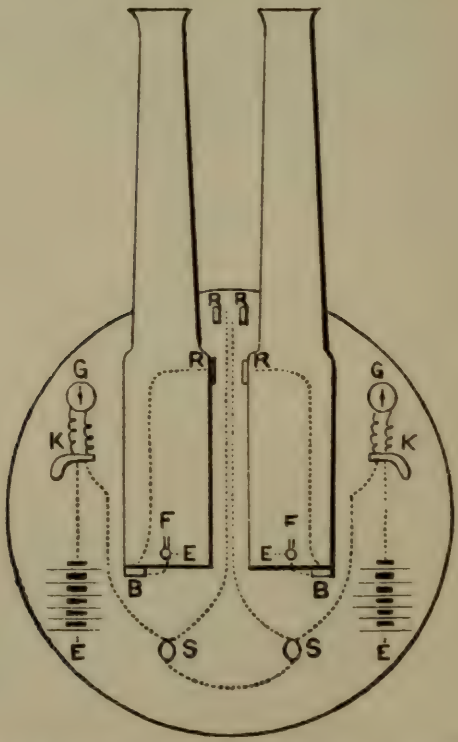


Fig. 3—LOCKED BREECH

THE KRUPP MODIFIED WELIN BREECH SCREW.



6-INCH RAPID-FIRE GUN CIRCUITS.



TURRET CIRCUITS, 12-INCH BREECH-LOADING GUNS.

each round. There are two sets of sights, one on either side, two batteries, and naturally two distinct firing keys, which are in the form of a pistol, the trigger making contact on being pressed.

The circuit in each case may be traced from the negative pole of the battery through the firing key to a rubbing contact at the outer extremity of the recoil slide; a contact piece on the gun itself takes against this when the gun is fully run out, and only then is the circuit complete to the striker. The striker, so called from the fact that it is made to do duty as such when percussion fire is resorted to, consists of a steel tube filled with gutta-percha insulation, through the center of which runs the circuit, ending in a brass nipple, which takes against the contact piece on the fuse itself when the breech is closed. A mechanical device on the breech prevents this nipple from making contact until the breech piece is properly home, so that it would be impossible to fire the gun with the breech only partially in position. The nipple makes contact with a small disk that is well insulated from the brass cartridge into which the fuse is screwed, and the circuit proceeds from this disk to a thin platinum bridge embedded in priming composition and thence to earth, which is represented by the brass cartridge case and the gun. The positive pole of the battery being brought to the gun mounting picks up the return through the gun.

The turret or barbette circuits in battleships of the later types, such, for instance, as the *Majestic* class, serve as a very good illustration of the precautionary measures that are provided to insure against accidental firing of the gun when in an unsafe position, or before the breech is properly closed.

The safety arrangements may be divided into four, namely, the firing key, the ring switch, the run-out contact, and the breech-locking bolt. If we trace the circuit in the accompanying diagram we shall see that it is in duplicate, one battery being placed on each side of the turret and the connections between each battery and its individual gun exactly similar. Thus, in either case we start from the negative pole of the battery and come first to the firing key. This key or pistol is represented in the figure at K, and it is placed in the sighting hood, from which the captain of the gun lays his sights.

The circuit is seen to continue from K to the rear switch S.

The rear switch has two duties to fulfill, the most important being the safety it provides for the man whose duty it is to place the fuse or tube in the gun. If this switch is at "Off," it is obvious that the tube can not be fired while the man is immediately in rear of it, and thus cause, by the recoil of the gun, the death of the man attending the breech mechanism. It is under his control, and he only puts it to "On" when he is in a safe position immediately before the gun is reported ready.

From this switch the circuit proceeds to R, the run-out contact. This contact is made by the gun itself, automatically, upon reaching the limit of its run-out position, so that in case of the gun not being properly run out to its full extent it will be impossible to fire it. Were this safety arrangement not there, the gun might be fired when only half out. Its recoil would then be only partially absorbed by the hydraulic cylinders and disastrous consequences might ensue. In any case there would be a heavy strain brought upon the mounting. From this contact we now come to the fourth and last safety arrangement, which is the breech-locking bolt B.

The breech-locking bolt provides against the gun being fired when the breech is not properly closed, and in order to explain its action it will be necessary first to examine the means by which the breech is screwed home.

After the gun has been loaded, a cradle, in which rests the breech piece, is moved over by a hydraulic ram until it is opposite the chamber. A second ram then pushes it from the rear into the gun.

So far the breech piece is not locked in any way, and it is not until the gun begins to run out that a projection on the breech piece, taking in an inclined slot on the carriage, forces it to revolve within the chamber and the screw threads to take.

Until the breech has performed nearly a quarter of a turn it is not properly home and the gun is not safe. To provide against the possibility of the gun being fired without the breech being properly and securely closed, this fourth safety device is designed. It consists of a locking bolt which works on an inclined plane as the gun runs out, and the circuit is passed through this bolt, insulated from it, of course, so that when the bolt locks the breech piece to the gun the fact of its coming into position completes the circuit.

The circuit proceeds then from the locking bolt direct through the contact piece on the gun tube, thence through the fine fusible bridge embedded in priming composition, and thence to the brass body of the gun tube, where it picks up an earth return in the metal of the gun itself, the positive pole of the battery being led to earth.

With the circuit as at present described it will be seen how either battery may be made to fire its own particular gun, but in practice it is often necessary to fire both guns simultaneously.

The captain of the barbette or turret usually takes up his position in one of the sighting hoods, and lays both guns from that position—it would cause waste of valuable time if he had to change his position for each gun—and so the two circuits are connected together by a wire between the two switches *S*. It will now be seen that either battery may be made to fire the guns singly or both simultaneously, according to the connection made by the switch at *S*, so that if either battery fails the other may be substituted.

A vertical galvanometer, offering a resistance of 1,000 ohms, can be switched into the circuit in place of the firing key immediately before the gun is fired, and this will show if the circuit is complete. Its high resistance renders the current too small to fire the fuse, and thus the circuit may be tested when the gun is loaded.

SIGHTING GUNS.

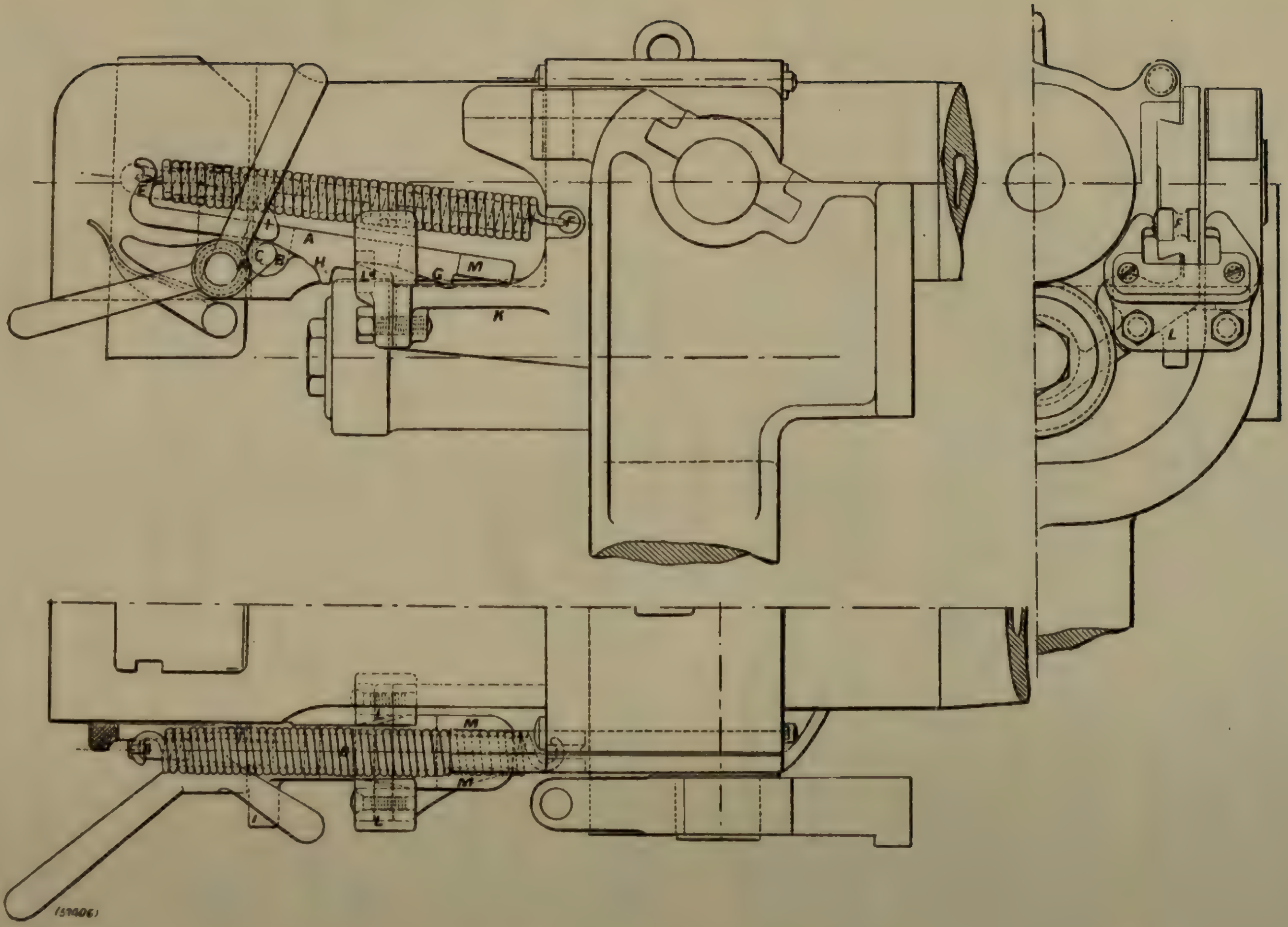
The *Naval and Military Record* of London states that the British Admiralty have directed the substitution of 3-pounders for the 7-pounder sighting guns for turrets and barbettes.

These sighting guns are mounted on the tops of turrets and barbettes, and, as they are controlled entirely by the training and elevating mechanism of the large guns, they prove most useful for instructional purposes besides enabling captains of guns to ascertain the exact aim of the large guns by the discharge of the sighters, thus effecting an economical saving of ammunition and contributing substantially to the preservation of the life of the large weapons. The breech of these sighting guns is connected to that of its parent gun by a long adjustable link bar, so fixed that the movement of the elevating gear of the large gun gives corresponding elevation to the two guns.

SECONDARY BATTERY GUNS.

The French navy has adopted the 37-millimeter (1.46-in.) Maxim for ships and the 32-millimeter (0.81-in.) Maxim for torpedo boats.

The Hotchkiss company have developed their 3-pounder gun, making it semi-automatic. This gun is identical with the standard Hotchkiss rapid-fire 3-pounder on the automatic recoil mounting, with the exception of the semi-automatic gear. By this arrangement the operations of opening the breech, extracting and ejecting the spent car-



DETAIL OF 47 MM. HOTCHKISS SEMI-AUTOMATIC GUN.

tridge case, and closing the breech are automatically performed, it being only necessary to load and fire by hand. This mechanism does not appreciably complicate the gun, only three moving pieces being added to the gun proper and three fixed parts to the carriage. The gear is extremely simple, and is so arranged that its action is uninfluenced by a reduced recoil or an incomplete return to battery. The normal recoil of the 3-pounder gun is about 100 millimeters, but the semi-automatic gear will perform its functions with a recoil of only 75 millimeters, or, when the gun fails to return to battery, by 10 millimeters.

The semi-automatic mechanism consists essentially of an actuating slide pivoted to and recoiling with the crank handle of the gun; a stout spiral spring in tension between the end of the slide and a fixed part of the mounting; a buttress plate bolted to the mounting, and a locking spring attached to the extractor.

The recoil of the gun is only utilized in extending the spiral spring and in bringing the slide in line with the buttress plate; the breech is opened and the spent cartridge case is extracted and ejected during the return of the gun to battery.

The extractor is so arranged that on the ejection of the spent case it locks the breechblock in the open position and holds it against the tension of the spiral spring. On introducing a fresh cartridge into the gun it strikes the extractor and automatically releases the breechblock, which is then instantly closed by the spring. The gun is then ready for firing.

The advantages of the semi-automatic gear are threefold: First, the gun's crew is reduced to the gun pointer and the loader; second, the rapidity of fire is greatly increased; third, there is perfect safety in the case of a hang fire, as the breech will only open after the discharge of the piece; finally, the gear may be instantly disconnected from the gun, when the piece may be worked by hand as an ordinary rapid-fire gun.

The plates show the gear in elevation, plan, and partial rear view. The detail of the extractor is not shown, being unessential to a clear understanding of the mechanism. The breech-block, with its maneuvering, firing, and extracting mechanism, is identical with the standard Hotchkiss rapid-fire mechanism, except that the extractor guide in the breechblock is cut away near the top to form an abutment, which brings up against the extractor stud when the breech is held open before loading.

As compared with the standard model, the extractor is lengthened to the rear, and formed into a hook which locks against the rear face of the breech housing when the breech is opened, being forced and held in this position by the locking spring. This arrangement is only necessary to prevent any chance of the extractor rebounding and allowing the breech to close before the gun is loaded.

The actuating slide A is a single forging, which is pivoted by means of the eye B to the secondary crank C, which is formed on the crank handle. The spiral spring D is hung between the hook E formed at the end of the slide, and the eye F drilled in the cradle of the mounting. On the underside of the slide are formed the buttress G, the lifting cam H, and on the side the starting arm I. The right side of the cradle is formed into the bracket K, and to this is bolted the buttress plate L by means of two stout bolts. We may now describe the action of the mechanism.

Suppose the piece to be discharged. The gun will recoil, drawing with it the slide A, and extending the spiral spring D. When the recoil reaches 75 millimeters the buttress K will have passed beyond the face of the buttress plate L, and the tension of the spiral spring will cause the slide to rotate around the stud on the secondary crank C until the tail M of the slide bears upon the top surface of the buttress plate. The tail slides over the buttress plate until the end of the recoil. On the return of the gun to battery the buttress G strikes against the face of the buttress plate L, and as the slide can not continue its movement with the gun, it causes the breech to open, first by the starting arm I acting with a powerful leverage against the upper branch of the crank handle, and finally by the action of the eye B acting with a short leverage upon the crank C. The opening of the breech accomplishes the extraction and ejection of the spent cartridge case precisely as in the case of the ordinary quick-firing gun, and when fully open the breechblock is locked in this position by the extractor stud engaging with the abutment formed in the extractor guide. The tail of the extractor engaging the rear face of the breech housing prevents any rebound or unintentional unlocking. On the ejection of the cartridge case the lifting cam H strikes the hub of the crank handle at N and causes the slide to pivot about the stud of the crank C, releasing the buttress G from its engagement with the buttress plate L. The tension of the spiral spring now acts to raise the breechblock to the closed position, the latter being only prevented from rising by the extractor, as already described. On introducing a fresh cartridge into the gun the flange of the case strikes against the extractor, causing the latter to unlock and move forward when the breechblock is free, and immediately closes under the action of the spiral spring. The piece is now ready for another round.

The newspapers state that experiments with this gun are being held at Whale Island by the English admiralty. Two samples of this gun, practically the same, are being tried—the one English, the other French.

This piece has already been adopted by two of the European Governments. In another patent of this firm the breechblock is opened through the engagement of a finger attached to the block-operating axle with a hinged arm carried by a stationary part of the gun mounting; the axle is caused to turn during the recoil and thus open the breechblock.

On the return movement the block is locked when the finger is automatically tripped by a spring, which is compressed by the axle in turning during the opening.

SECTION II.

SMALL ARMS.

The magazine rifle is still being developed in several of the navies of the world. Several of the existing rifles have been improved and some new ones have arrived at the issuing period. The Boers have established the efficiency of the German Mauser of 7-millimeters carried by them.

English newspapers state that in England, the Lee-Enfield rifle is about to be superseded by a new small arm from the Government works at Enfield. Orders have been given for 1,000 to be manufactured and issued to the service for further trial before replacing the existing arm.

The breech action and bolt remain the same as before, with the addition of a new safety locking arrangement. The trigger is also provided with a draw pull, the trigger yielding for a short space upon exercise of pressure upon it before reaching the point of discharge. The carrier system of loading is used instead of the clip; under this system the cartridges are dropped into the magazine receptacle and the empty carriers thrown away.

The barrel is covered with a wood casing.

Much comment has been made on this piece as being a compromise between an infantry rifle and a carbine, the sights being too close together, and its being so short as to constitute a handicap in bayonet encounters.

THE GERMAN INFANTRY RIFLE.

This is an improvement on the old rifle. The common points in the 1898 and the old 1888 model consist in the use of the same cartridge, caliber, rifling, and chamber. The exact caliber of the new gun is 7.92 millimeters. The extreme range is 4,000 meters. At 100 meters 80 centimeters of dry pine can be pierced, and at 1,800 meters 50 centimeters of dry pine; at 300 meters 7 millimeters of iron can be pierced, but it has failed to pierce 9.5 millimeters of good steel. The velocity of the projectile at 25 meters from the muzzle is 620 meters per second. The ballistic value of the gun is not greater than that of the model of 1888.

The following description of the arm is by Col. E. Hartmann, published in the *Kriegstechnische Zeitschrift.*

The new model was first distributed, by way of experiment, to a few battalions of infantry. The experiments covered three whole years, thus making it possible to test the weapon slowly and thoroughly, and it was only after the results had proved entirely satisfactory that it was definitely adopted as "Model 98."

It is to be noted that in the construction of the new rifle (figs. 1 and 2), which is based on the principle of construction of the small-caliber Mauser magazine rifle, the endeavor has been to produce a weapon whose efficiency would in no way be impaired through carelessness or inexperience in handling. At the same time the separate parts, as also the rifle as a whole, are of such simplicity that it can be placed in the hands of any soldier and completely mastered by him after a very short period of instruction.

The following description of the different parts of the rifle M/98 is based on the supposition that M/88 is known. The parts of the weapon are: The barrel, sights, breech, stock, hand protection, mountings, accessories, and side arm.

The barrel.—By doing away with the barrel jacket it has become possible to give greater strength to the barrel itself, while preserving the four grooves. The barrel consists of successive cylinders or truncated cones, each stronger than the preceding one, from the muzzle to the breech. These cylinders permit the expansion of the barrel when it becomes heated, without causing any jamming that might impair the firing efficiency. To this end the requisite play is allowed in the stock.

The rear part of the barrel terminates in a screw thread, forward of which is a reenforcement designated as the band. On this band is marked on each rifle the caliber in hundredths of millimeters. The caliber has remained the same as heretofore, namely, 7.9 millimeters; but on the band the hundredths are also indicated, as, for instance, 7.92.

The sights (figs. 3 to 6).—In M/88 the sighting device was secured to the barrel jacket; in M/98 it is secured to the barrel itself.

The sight, consisting of the sight foot, the flap, and the sliding notch, has only one notch, while M/88 had four. The innovation results not only in greater simplicity, but also obviates a confusion of the sights while aiming, and hence the use of the wrong sights. The old block sight has been replaced by a quadrant or curved sight in the shape of a sliding sight. In M/88 the sight commenced with 250 meters. In M/98 the first distance of the sight is 200 meters. Then there follow in M/88 the small flap raised for 350 meters and the large flap, with sliding notch entirely turned down, for 450 meters. In M/98 the sliding notch is adjusted in the most rearward position for 200 meters, in which case the sliding notch rests evenly and firmly on the sight foot. Then follow immediately the distances of 300 meters, 350 meters, 400 meters, 450 meters, etc., with 50 meters interval up to 2,000 meters. Thus there is no intermediate position between 200 and 300 meters. The positions for even hundreds are designated by marks and figures on both guide lugs; the intermediate positions for half hundreds are not indicated separately. In this manner the sight can be easily adjusted by the marksman in any position. It is done by depressing the two buttons covered with checkering and the springs, whereupon the sliding notch can be pushed forward and adjusted to the different sighting marks. The latter are located, for the rear surface of the sliding notch, on the upper face of the sight foot, on the right-hand side for even hundreds and on the left-hand side for uneven hundreds. The sighting marks for the indicators of the slide are located on both sides of the sight foot.

When the sliding notch is pushed forward the notch of the sight rises so as to give the required elevation for the corresponding distance. This sight is protected by German patent; it is also known in the army as the "Lange sight," and in the patent it is designated as "curved sight."

The fore sight rests with its foot in the stud of the fore-sight socket. The latter is a thin, short tube pushed over the forward end of the barrel, to which it is soldered and further secured by a screw which is not visible.

The fore sight is in the proper position when the notches on the foot and stud form a straight line. But it is slidable laterally in order to compensate by proper adjustment any lateral deviations during firing. Such lateral adjustment of the fore sight, however, presupposes a weapon in every respect normal and perfect, for if the cause of such deviation lies somewhere else the adjustment of the fore sight will be of no avail.

The breech.—The breech is formed of the breech-bolt receiver, with catch and ejector, lock, trigger, and trigger plate, and magazine adapted to receive several charges.

In the breech-bolt receiver the rear part of the bolt path is closed at the top and is called the receiver bridge. On its front face is the recess for the reception of the clip. The receiver bridge serves at the same time as a reenforcement of the receiver against bending and other injuries and increases the durability of the receiver.

The rearward motion of the breech block is limited by the bolt stud. The new feature is that the bolt stud serves at the same time as ejector, for the latter and the bolt stud are connected movably with the receiver by means of the stud screw and are actuated by the double spring. When the bolt is slid back the cartridge case strikes against the ejector as the latter enters the left bolt stud and is thus thrown out to the front.

The parts of the breech block are: the bolt, firing pin, firing-pin spring, sleeve with push pin and spring, safety catch, firing-pin nut, and ejector with ring.

In the breech block of rifle M/98 the following new features are to be noted. The place of the former movable bolthead and bolt has been taken by the bolt only, so that the recoil is taken up directly by the bolt and its stud without the cooperation of any intermediate part. A further advantage of this innovation consists in the fact that a discharge without the bolthead, which could happen in M/88 in the hands of careless and imprudent men and which in some cases, though seldom, has led to serious injuries, is henceforth precluded.

The forward part of the bolt has two longitudinal openings side by side, which in the case of cracked cartridge cases or the bursting of a percussion cap—though both very exceptional occurrences—prevent the gases from escaping directly to the rear; they are instead conducted to the side, where they escape without in any manner molesting the marksman.

In M/98 the ejector has been considerably strengthened; it is several times the size of the former ejector, and constructed so as to engage at once with the groove in the bottom of the cartridge when the breechblock moves forward, so that the cartridge becomes firmly connected with the breechblock while the former slides over the bolt path of the receiver before it is introduced into the cartridge chamber. Thus the jamming together of two cartridges during loading becomes impossible, since every time the bolt is retracted with the weapon loaded the cartridge also is drawn out again. It can therefore not happen that when the breechblock is retracted the cartridge is jammed in the cartridge chamber or remains lying on the bolt path, as was possible with M/88 in case of faulty or careless handling. It may therefore be said once for all: when the breechblock is retracted the cartridge entered also recedes. Hence it is also impossible for a second cartridge to strike the percussion cap of the first cartridge entered, and thereby set it off and explode it. It should be stated, however, that such explosions were very rare occurrences in M/88, and then resulted only in very slight injuries to the hand owing to the tearing off of the bottom of the cartridge.

The magazine, which is adapted to hold several rounds, is of entirely new construction. While in M/88 the cartridge frame was inserted into the weapon, in M/98 the five cartridges are arranged upon a clip of much lighter weight, from which they are readily slipped off into the magazine. When the weapon is closed, the clip is automatically thrown to one side. It has therefore become possible to close the magazine at the bottom, so that the entering of sand, dirt, etc., is precluded.

The lower surface of the magazine being even with the stock, M/98 has no projection on the outside, thus having the appearance of a single loader. This circumstance, moreover, has greatly facilitated the shouldering and carrying of the weapon.

While in M/88 the cartridges lay in the magazine on top of each other, they are now arranged in zigzag, in two rows of two and three, respectively, and the feeder has a zigzag-shaped spring. The cartridges, however, can also be loaded singly without the clip, in which case they have to be pressed into the magazine and the resistance of the feed spring has to be overcome. During pauses in firing the marksman can therefore refill the partly emptied magazine. The removal of the cartridges from the magazine is effected by moving the lock forward and backward and taking the cartridges out singly.

The bottom of the magazine can be easily taken off by pressing with the point of the cartridge on the retractable bolt and pushing the bottom plate a little to the rear. The zigzag feed spring extends and lifts off the bottom of the magazine, thus enabling the soldier at any time to examine the interior of the magazine and remedy any irregularities, remove dirt, etc. The bottom of the magazine can be easily replaced with the palm of the hand, the engaging of the forward part indicating that the bottom has taken firm hold again.

The stock (figs. 7, 1, and 2) consists, as heretofore, of the butt, the small of the stock, and the long part; but, similar to the modern sporting gun, it has a so-called pistol grip, designated as "hand support." It is a decided hump-like projection on the under side of the small of the stock, and makes it possible at all times to set the rifle firmly against the shoulder, which feature is highly appreciated in the army. This hand support interferes in no manner with the handling of the weapon, and is not noticeable when presenting arms.

The object of the barrel jacket of M/88 is partly accomplished in M/98 by the hand protection, which is a new feature. It completely covers the barrel from the sight to about 2 centimeters beyond the lower band and facilitates the handling of the weapon, especially when the barrel has become much heated (figs. 1 and 2).

The side arm (figs. 8, 9, and 10).—The side arm 98 consists of the blade with hilt and scabbard. The blade, with blunt back, has a groove on both sides. In some of the infantry rifles for chasseurs and sharpshooters the back has a double-tooth saw. The blade is considerably longer than that of M/71–84, which was retained for M/88.

It is to be noted that the blade of the bayonet 98, when fixed, is no longer on the right-hand side, as in M/88, but underneath, the axis of the barrel. This is of great advantage for safety in striking in close battle, where the foot soldier needs a good striking weapon, and always will need it, notwithstanding all progress in the effectiveness of small-arm fire.

Owing to the peculiar shape of the blade with blunt back, this side arm combines, when the bayonet is unfixed, the advantages of a bayonet with those of a cut-and-thrust arm. It may therefore be designated as a true sword bayonet.

The hilt is not of brass, as heretofore, but is made from the pommel, which is in one piece with the blade, to the crosspiece which extends only on one side, of walnut, chamfered and oiled on both sides. At the back of the pommel is the case, which serves to receive the bayonet stud and the forward part of the cleaning rod. For the reception of the cleaning rod, the tang (fig. 11) is conveniently hollowed longitudinally from the forward end of the case to the crosspiece support. Back of the crosspiece, the wooden hilt is provided with a hole to facilitate the cleaning of the cavity for the cleaning rod. The chape and point of the leather scabbard are not made of brass, as heretofore, but of sheet steel (fig. 9).

The location of the blade below the axis of the bore, when the bayonet is fixed (fig. 12), considerably lessens the deviations of the projectile during firing. In connecting the side arm with the rifle in M/98, care has been taken to leave the barrel entirely free. The muzzle is no longer surrounded by a ring as heretofore; the side arm, on the contrary, rests in a special stud in the upper band, thus obviating the danger of bending the barrel and injuring the muzzle in fixing and unfixing the bayonet, which operations must still be performed with due precaution.

The ammunition.—No change has been made in the ammunition. The packing, of course, is done in clips instead of cartridge frames.

Data as to weight and dimensions of rifle M/98.

	Average weight.		Length.	
	kg.	*gr.*	*m.*	*cm.*
Rifle 98	4	100	1	25
Bayonet 98, with blunt-back blade, including scabbard	—	580	—	68.4
Bayonet 98, with blunt-back blade, without scabbard	—	430	—	65.6
Bayonet 98, with saw-back blade, including scabbard	—	675	—	68.4
Bayonet 98, with saw-back blade, without scabbard	—	505	—	65.6
Clip	—	7	—	.....
Cartridge	—	27.88	—	8.25
Powder charge (ordinary black powder)	—	2.67	—	.....
Projectile	—	14.70	—	3.13
Clip, with 5 cartridges	—	146.40	—	.....
Packing box, with 3 charged clips	—	471.87	—	.....
Packing case containing 15 packing boxes (225 cartridges)	7	279	—	......
Cartridge box 98 containing 5 packing cases (1,125 cartridges)	40	515	—	......
Blank cartridge	—	11.80	—	......
Clip with 5 blank cartridges	—	66	—	......
Packing box containing 45 blank cartridges	—	614.50	—	......

It should be noted that the length of the side arm M/71 was only 60 centimeters, and its weight without saw back, including scabbard, 920 grams, without scabbard, 725 grams.

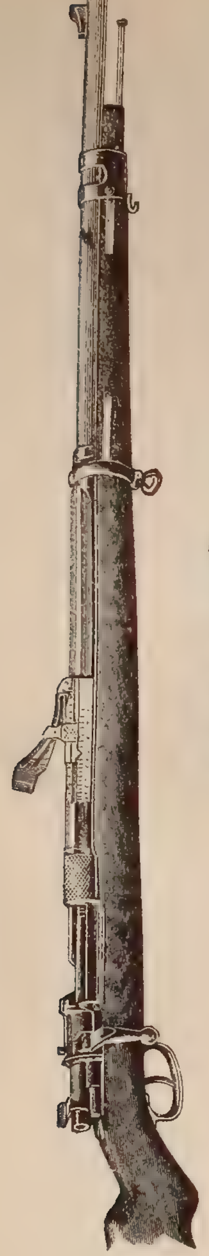
As to the ballistic properties of rifle M/98, no changes have occurred from M/88, so that both weapons are of equal value in that respect. Owing to this circumstance and the fact that the cartridges are identical, it is, in our opinion, entirely admissible to use the two types side by side in the army during the period of transition.

A NEW MANNLICHER RIFLE.

[From *Arms and Explosives*, London.]

The Steyr factory have been engaged for some time past in working out improvements in the Mannlicher rifle; and in the particular direction of reducing the compass of the magazine they have had the advantage of studying, in a practical way, the mechanical working of the Spanish Mauser. In this latter rifle the magazine has been shortened, so as not to extend beyond the woodwork of the stock, by a process of widening the magazine so that the cartridges shall lie zigzag fashion. The only difficulty which is presented by such a form of construction is to insure the satisfactory feeding of the cartridges into the position where they will come into the track of the bolt ready for being carried forward into the chamber. That this system works with fairly satisfactory results is shown by the fact that the English Mark II service rifle is arranged on the same plan.

The manufacturers of the Mannlicher rifle have adopted another system for attaining the desired compactness of the magazine. They have made use of a revolving



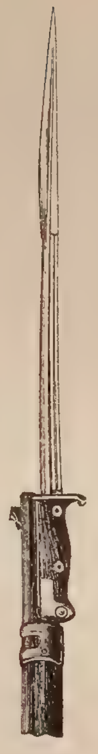


Fig. 1.

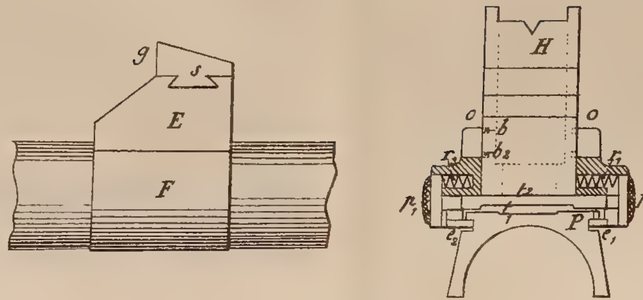


Fig. 9.

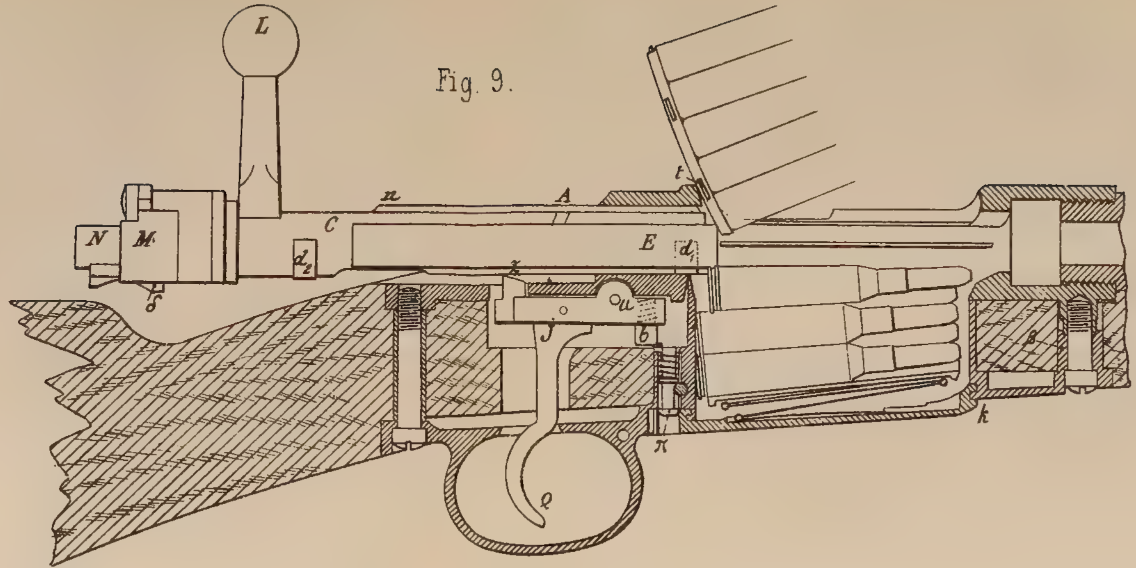


Fig. 14.

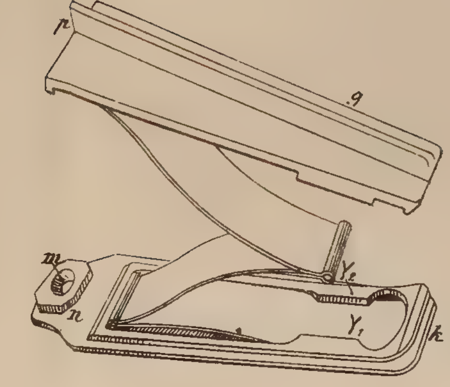
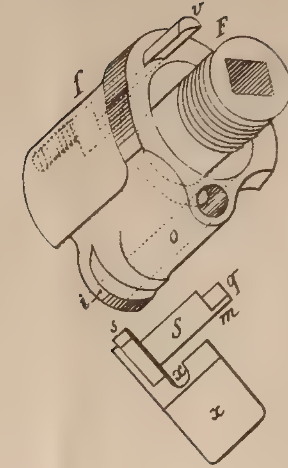


Fig. 13



Plan.

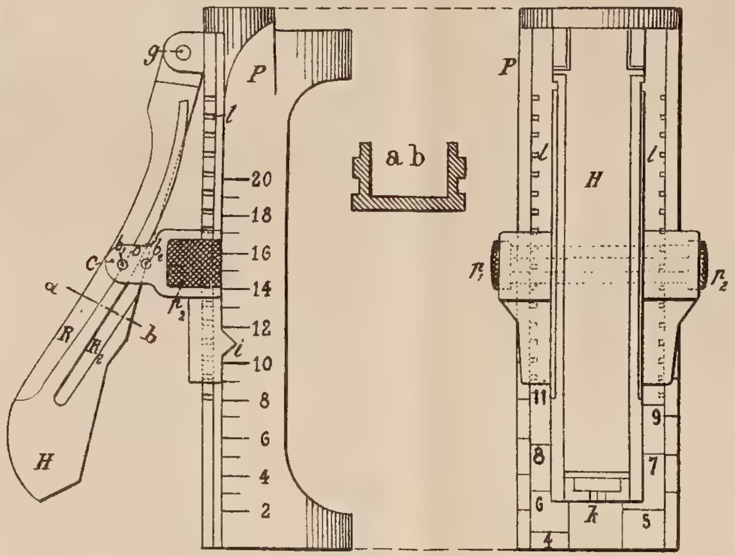
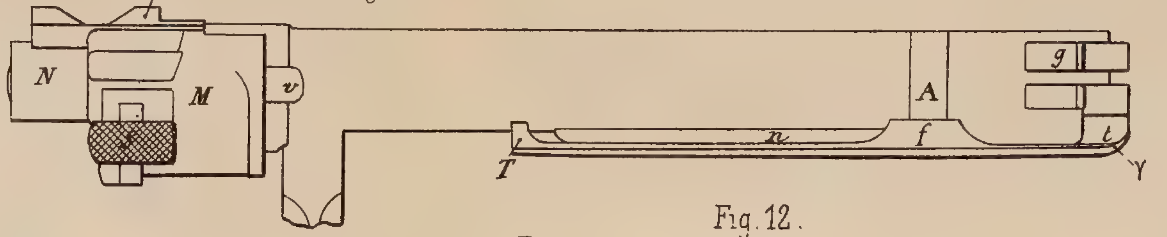


Fig. 5

Fig. 10.



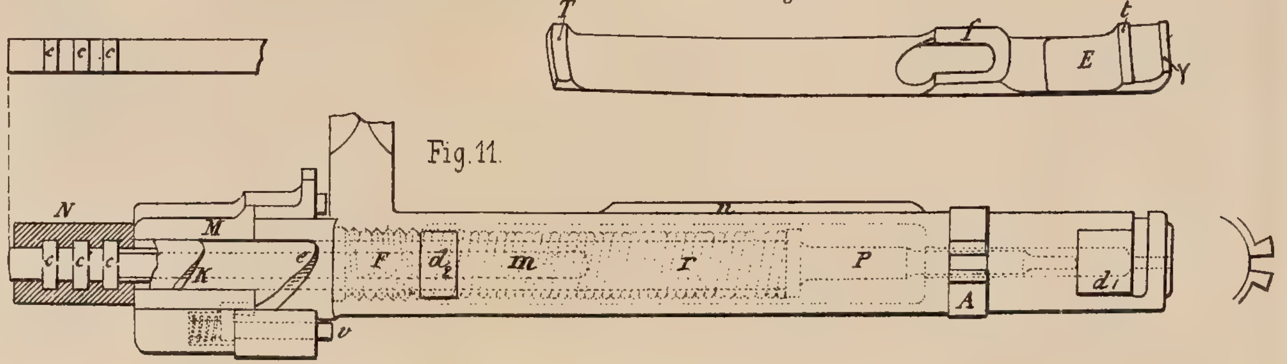


Fig. 12.

Fig. 11.

Fig. 6.

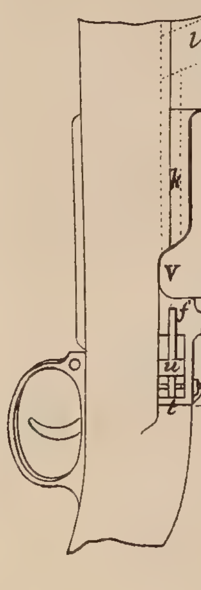


Fig 8.

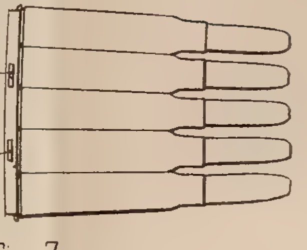
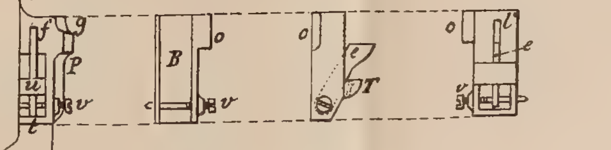
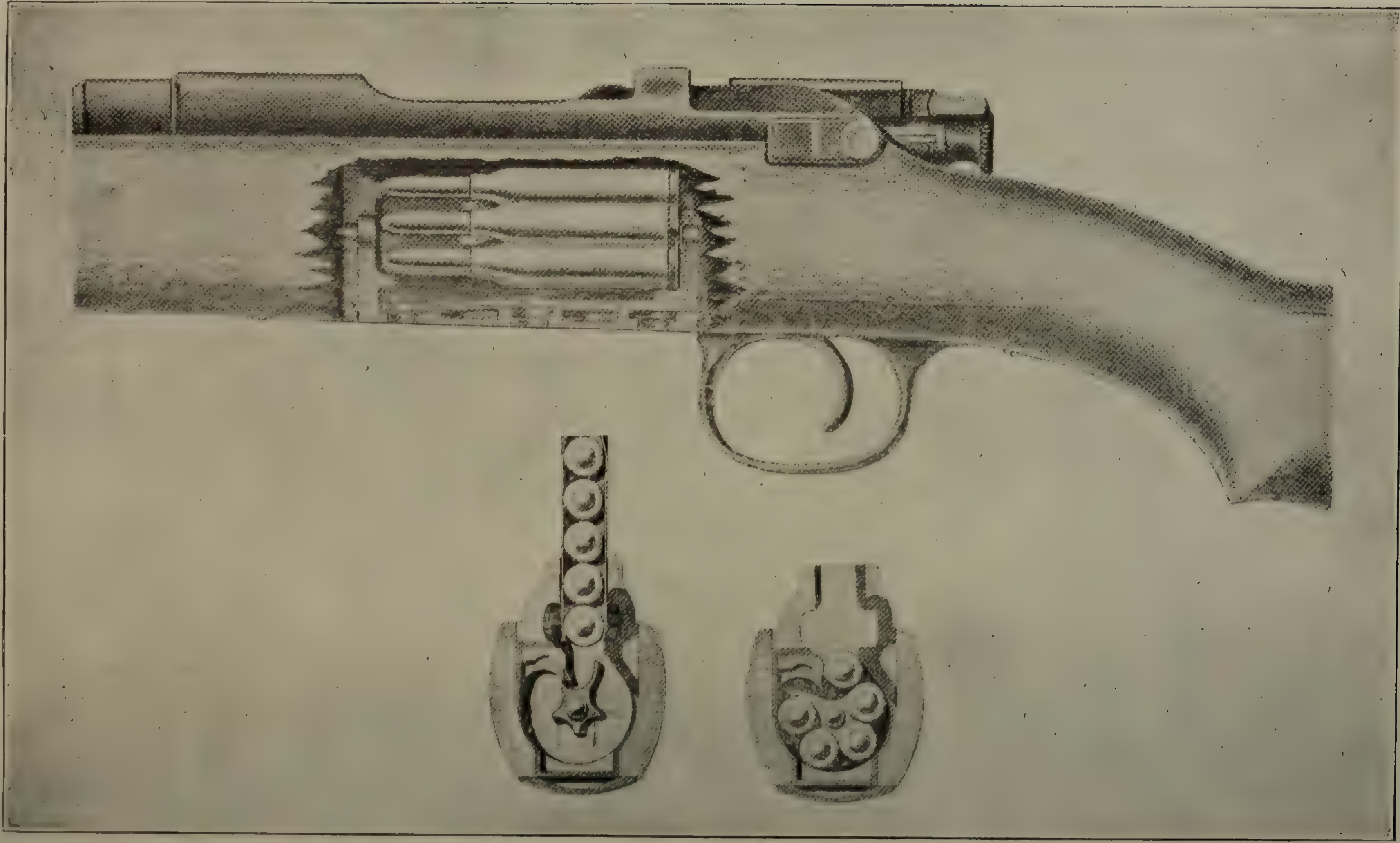


Fig. 7.



NEW GERMAN RIFLE, MODEL '98.



NEW MANNLICHER RIFLE.

carrier, which is illustrated in the cross sections in the figures. A clip, in general appearance similar to that for the Mauser rifle, serves to hold the five cartridges at the rim. Two upstanding guides over the rear of the receiver of the rifle are shown. The clip containing the cartridges is placed within grooves formed in these pieces, this position of parts being shown in cross section. In this last-mentioned illustration the sectional form of the carrier is plainly shown. It has five arms, which serve to accommodate five cartridges arranged in a circle, each in its own groove. An extra-long extension of one of the projecting wings of the carrier meets the first cartridge which enters the magazine. The stripping of the cartridges from the clip forces them into the magazine, and the revolving carrier rotates against the pressure of a spiral spring in the center of the carrier. As the carrier rotates under the pressure of the first cartridge a fresh recess is exposed, and the process of filling continues until all five have been properly located in the magazine. The completely filled carrier is shown in the figure, the spiral spring all the while tending to press the cartridges out of the magazine and into the receiver. It will be noticed in the figures that the interior surface of the magazine is made of suitable roundness so as to provide a smooth surface to hold the cartridges in position on the carrier, and at the same time to permit their free movement when the carrier rotates. The figures show clearly the action of a stop which projects into the diagonal passage forming the entrance to the magazine. This stop is held in place by a light spring, which gives way to the superior force exerted in the filling of the magazine, and also allows the bolt to carry the top cartridge into the chamber. The spring is at the same time of sufficient strength to enable the stop to prevent the cartridges from being pushed out of the magazine by the action of the spiral spring which operates the revolving carrier. A thumb-piece extension of the stop is carried through a hole in the action, where it may be operated by the shooter. Pressure on this thumb-piece serves to depress the stop, so enabling the carrier spring to empty the magazine. The cutaway portion of the figure shows a side view of the interior of the magazine, and clearly indicates the position of the parts when the magazine is filled.

In passing, we may mention that the form of cartridge clip used is interesting, in so far that it has been made in a single piece. The Mauser clip has a flat steel spring for holding the cartridges frictionally in place, while the clip of the late American Lee rifle has a wire serving a similar purpose, which is unlocked when the clip enters the rifle. The spring has been dispensed with by making two saw cuts in the bottom of the clip and expanding the resulting clip upward, so as to press against the base of the cartridges. Frictional grip on the end cartridges is provided for by saw-cutting the flanges of the clip and pressing them inward so as to grip the case. These bent ends are shown in the figure.

The portion of the magazine represented by the revolving carrier, and the base plate upon which it is mounted by means of uprights, may be bodily removed from the rifle. The bottom plate lies flush with the woodwork of the stock on the underside of the rifle, and it has a hole into which any pointed object, such as the bullet of a cartridge, can be inserted. This releases a spring clip, and the plate is then free to turn around its center. This turning of the plate frees it from the circular dovetailed notches which hold it, the plate and carrier being then free to leave the rifle.

Among the detailed improvements of this rifle several are worthy of special notice. The illustration shows that a half pistol grip has been formed on the stock. Further, a wooden cover (not shown in our illustration) has been fitted over that portion of the barrel which is likely to come into contact with the hand of the shooter, so getting rid of the disadvantages incidental to a barrel being heated by repeated firing. Another little item worthy of comment is that the bolt handle has been hollowed out, so removing an ounce or so of surplus metal from a place where its distance from the axis of the barrel is likely to create undue jump.

The sights on this rifle are a modification of the type of graduated step sight which has been associated for many years with certain of the Winchester rifles. A hinged leaf is provided with a crossbar at the top, carrying a V notch in the center. This leaf lies in a horizontal position for short-distance shooting, and the V notch is raised by the bearing of an adjustable crossbar upon suitably sloped surfaces. The sliding crossbar locks into one or another of the series of notches which have been cut to suit the various ranges.

The caliber of the rifle is the standard 0.256 bore, which has become so popular in England, the ammunition remaining unaltered.

It is reported that Austria will arm her emergency naval reserves with this weapon.

THE FREDDI AUTOMATIC RIFLE.

The following description of this arm is from the *Rivista di Artiglieria e Genio:*

This new rifle is a repeater and is loaded automatically. The force of the recoil is utilized for opening the breech, expelling the empty cartridge case, reloading the weapon with a new cartridge, reclosing the breech, and placing the percussion mechanism in the firing position, so that the marksman can discharge successively all the cartridges contained in the magazine simply by depressing the trigger, without the necessity of any other movement or of removing the weapon from his shoulder.

As soon as a round has been fired the barrel slides back in suitable guides, with the breech closed, and bends two spiral springs, one secured to the barrel, the other to the breech bolt. When the barrel has traveled a certain distance it slides forward again, being returned to its original position by the reaction of the spiral spring connected with it. The breech bolt, however, does not at once follow the movement of the barrel, but remains behind, being held back by a suitable tooth. In this manner, when the barrel slides forward, the breech opens and the empty cartridge case is thrown out, while a new cartridge, contained in the magazine, takes its place in the breech, in line with the chamber. At the precise moment when the barrel, in sliding forward, reaches its proper position, the tooth which held back the breech bolt is lowered. The latter, in its turn, then slides forward, impelled by the spring connected with it, pushes the new cartridge into the chamber, and closes the breech. When the breech bolt closes, the firing pin can not complete its entire course, because it encounters the sear tooth which holds it back; it therefore remains behind, cocked. The pulling of the trigger lowers the sear tooth and the shot goes off. The same action is repeated as long as there remain cartridges in the magazine.

The mechanism employed to obtain this result may be applied to any firearm ot whatever caliber and may be adapted to any loading device.

The mechanism shown in the annexed plate is applied to a repeating rifle.

The annexed plate shows:

Fig. 1. A longitudinal section of the weapon seen from the right, with the breech bolt open.

Fig. 2. Part of the barrel, with the breech bolt open, seen from the right; tang and mechanism.

Fig. 3. Part of the barrel, with breech bolt open, seen from the left; tang and mechanism.

Fig. 4. Nut.

Fig. 5. Firing pin.

Fig. 6. Breech-bolt cylinder.

Fig. 7. Tang seen from the top with rod carrying the breech-bolt spring.

Fig. 8. Safety position.

Fig. 9. Longitudinal section of breech with breech bolt closed and firing pin uncocked.

Fig. 10. Longitudinal section of breech with breech bolt closed and firing pin cocked.

Fig. 11. Longitudinal section of breech with breech bolt open.

The weapon shown in the drawings is composed essentially of the following parts: A movable barrel with breech and breech bolt with slidable cylinder; a tang under the barrel which serves as support and guide for the barrel itself and its breech bolt and connects the various mechanisms; a stock and a magazine arranged under the breech.

Barrel.—On the barrel are two guides a, a^1 (figs. 1 and 2), one under the breech and the other on the transmission arm A. These two guides are designed to slide in corresponding grooves a^2 a^2, a^3 a^3 (figs. 7 and 1), cut in the tang and the tube A^1, containing the spring, and serve to guide the movement of the barrel caused by the recoil, so that it will always be in the line of the axis.

The transmission arm A, besides serving as a guide, puts the barrel in communication with the spiral spring under it, to which it transmits the force of the recoil acquired at the moment of the discharge, and to the barrel it transmits the force due to the reaction of said spring when it once more relaxes.

This spiral spring is contained in a suitable tube A^1, secured in the stock below the barrel and forming a prolongation of the tang. The tube A^1 has a shoulder a^4 (fig. 1) which serves to limit the course of the barrel and determines its position after the recoil and after the reaction of the spring, opposed by the base of the arm A and by the rib a^5 (fig. 2) which projects below the rear part of the barrel.

Breech bolt.—The breech bolt (fig. 6) has a slidable cylinder and opens and closes by means of a screw cut in the interior of the nut and put in motion by the firing pin.

The breech bolt consists of three parts: a cylinder B, a nut B^1 (fig. 4), and a firing pin B^2 (fig. 5). The cylinder B has a rib b, which, sliding in the corresponding groove of the breech, serves the cylinder as a guide and prevents it from turning. It has recesses for the reception and functioning of the extractor, two shoulders b^2, a stud b^3 which serves it as a support on the nut, and back of said stud a cylindrical shank b^4 with longitudinal opening to allow the passage of the lugs b^5 of the firing pin. On the shank b^4 are two recesses b^6 which serve to connect the cylinder with the nut. The cylinder is perforated in the line of the axis to admit the firing pin and its lugs. To give access to the latter, the perforation is enlarged, its shape differing according to the shoulders b^2.

The nut B^1 (fig. 4) is cylindrical, and has on the outside three lugs. On the inside it has a cylindrical hole, two screw threads b^7 diametrically opposite to each other a recess for the rear end of the extractor, and two projections b^8 to connect it with, the cylinder. At the back it is closed by a cap, perforated by an opening b^9 to permit the passage of lugs b^5 of the firing pin, in assembling the breech bolt.

The firing pin B^2 (fig. 5) is a pin with truncated point, provided with two lugs b^5, and terminating at the rear in a guide b^{10} surmounted by a shield. Below the guide is a tooth b^{11}, and above it a recess b^{12}. On the right side of the rear end of the guide is another recess b^{13}.

The object of tooth b^{11} is to stop the firing pin back of the sear tooth; that of recess b^{12}, to receive the tooth c of the rod C (fig. 7); and that of recess b^{13}, to admit the flat bolt a^6 (fig. 7) which is to arrest the motion of the firing pin when the lever C^1 is put in the safety position.

The rod C is keyed to the tang and located on its right. It is provided with lever C^1 (fig. 7) and acts directly on the spiral spring, which in its turn acts upon the firing pin by pressing against the support a^7 of the tang, bending it downward, when the firing pin slides back to open the breech. The spring of the rod C is in itself sufficient to close the breech and consequently discharge the weapon. A small ring c^1 surrounding the forward end of the rod C, by means of a small tooth projecting therefrom, serves as a support and brake for the spiral spring.

Below the rod, at its rear end, is a tooth c^2 which, upon lowering the lever C^1, encounters the flat bolt a^6 and pushes it into the recess b^{13} of the guide of the firing pin, thus placing the weapon in the position of safety.

On the breech-bolt cylinder is located an extractor which, with the assistance of an expeller located on the breech, serves to extract the empty cartridge case when the breech bolt opens. This extractor also serves to maintain the nut firmly on the cylinder up to the time when it is to turn in order to close the breech.

Tang.—The tang (fig. 7) has a longitudinal guide groove, a^2 a^2, in the line of the axis, in which slide guide a of the breech and guide b^{10} of the firing pin. The tang, by means of the groove a^2 a^2, serves to guide and regulate the sliding movement of the breech bolt and barrel, wherein it is assisted by the guide groove a^3 a^3 (fig. 1), which is on the tube A^1 containing the spiral spring, with which it is connected in such manner as to form with it a rigid system, secured to the stock under the barrel, with its own axis parallel to that of the barrel.

Under the tang is the trigger mechanism, consisting of the trigger d (figs. 1 and 2), with the trigger plate d^1, to which are keyed the sear tooth d^3 and the barrel stud d^4, and of the lever d^5, which terminates at the rear end in the button d^6 and carries the cocking toe d^7, which limits the breech bolt.

The trigger plate d^1 and the lever d^5 are controlled by the spring d^8.

The sear tooth d^3 serves to keep the firing pin cocked when the breech bolt closes, opposed by the tooth b^{11} (fig. 5). The tooth d^3 is connected in such manner that as soon as it has been lowered, as the result of the pressure upon the trigger, it returns to its position automatically. This is to prevent the marksman, in case he should inadvertently continue to depress the trigger, from discharging the other cartridges remaining in the magazine.

The barrel stud d^4 prevents the barrel from moving backward when the weapon is in its normal state, and from being lowered, together with the sear tooth, when the trigger is pulled for the purpose of firing.

The cocking toe d^7 opposes the tooth of the firing pin b^{11} and maintains the breech bolt open. By depressing the button d^6 the cocking toe d^7 is lowered and the breech bolt released.

To the right side of the tang is connected the operating rod C, which slides along a grooved slot. This rod is joined to the breech bolt by means of the tooth c which enters the recess b^{12} (fig. 10). The barrel, when retracting as the result of the recoil, carries with it the firing pin, with the rod connected therewith, and bends its spiral spring. Upon depressing the button d^6, the cocking toe d^7 recedes and the spring relaxes, carrying the firing pin forward until it encounters sear tooth d^3, which opposes its further advance.

Upon pulling the trigger, the sear tooth lowers, the spring relaxes completely, and the firing pin strikes the cartridge primer and causes it to explode. As the firing pin moves forward, it pushes in its turn the breech bolt into the breech. At this point the rear end of the extractor lowers and releases the nut from the cylinder, and the nut, owing to the lugs b^5, which run along its inner screw thread, is compelled to turn and the breech commences to close.

The firing pin, at the moment of discharge, continues to advance, completing with its lugs the closing of the breech, and, running along the interior of the cylinder the short distance corresponding to the space allowed its lugs b^5 by the shoulders b^2, reaches with its point the cartridge contained in the chamber, and with the shield the cap of the nut.

To open the breech bolt, the firing pin is pulled back by means of the lever C^1 until the tooth b^{11} rests against the cocking toe d^8. In this manner the firing pin slides back, runs along the screw thread of the nut, causing it to turn, and releases the closure lugs from the corresponding recesses of the breech. At this point the two lugs b^5 of the firing pin oppose the cap of the nut, which latter, having completed its rotation, remains fixed to the cylinder from the rear end of the extractor; thus, by continuing to pull the firing pin backward, the latter draws along with it the breech bolt, compelling it to open.

To remove the breech bolt, after having opened it, the lever C^1 is made to lower, in order to release the tooth c from the recess b^{12}; the trigger is pulled to release the rib b of the cylinder from the barrel stud, and guide b^{10} of the firing pin is released from the groove a^2 of the tang.

To replace the breech bolt, guide b^{10} is introduced into the groove a^2 as far as the cocking toe d^7; the lever C^1 rises, pushing the tooth c into the recess b^{12}.

To close the breech, the button b^6 is depressed.

Safety.—When the firing pin is cocked and it is desired to place the weapon in the position of safety the lever C^1 is lowered. To this end there is on the right side of the tang, in line with the sear tooth d^3, an opening a^8 (fig. 2), which permits the lever to be lowered and, owing to its shape, maintains it firmly in that position. The firing pin is thereby released from the action of the spring of the rod and becomes secured to the tang by means of the flat bolt a^6 which, impelled by the eccentric tooth c^2 (fig. 8), enters the recess b^{12} of the guide b^{10} (figs. 5 and 10).

To return the weapon to firing position, the lever C^1 is raised to its original position.

Automatic closure.—For the purpose of obtaining the automatic closure of the breech bolt during firing, there is secured to the left side of the tang a connecting rod, E (fig. 3), which connects two lever arms, e, e^1, keyed to the tang; and to the left of the breech projects a shoulder, e^2. When the barrel, after the recoil, returns to its position, the shoulder e^2 of the breech encounters the arm e and compels it to bend down and swing around forward.

Through the connecting rod E the same movement is transmitted to the arm e^1, which, in swinging around, strikes with its lower end upon the lever which turns the cocking toe d^7 and causes it to lower.

The firing pin remains free, recloses the breech bolt, and the weapon is ready for another round.

Immediately after the discharge, as the barrel recoils, the shoulder e^2 encounters the arm e^1, compels it to swing around backward and, through the connecting rod, the arm e also is returned to its original position, ready to function anew when the barrel slides forward again to its position. Thus the breech bolt continues to open and close the breech automatically as long as there are cartridges left in the magazine or as long as it is desired to continue the firing. The time required for effecting this movement corresponds exactly to that required for the expulsion of the empty cartridge case and for allowing the new cartridge to take its proper position.

Manner of using the weapon.—In order to use the above-described weapon the breech bolt is opened, the cartridges are introduced into the magazine with one of the clips, the breech bolt is closed by depressing the button d^6, and the trigger pulled. Immediately after the discharge the barrel recoils with the breech bolt closed. Upon reaching the shoulder a^4 the barrel again slides forward while the firing pin remains behind, held back by the cocking toe d^7. The breech bolt opens, expels the empty cartridge case, and a new cartridge takes its position ready to be introduced into the chamber. When the barrel has returned to its position, the breech bolt closes again and the weapon is ready for the next round.

The weapon complete, with the mechanism mentioned, weighs about 3.85 kilograms.

THE FRIBERG-KJELLMAN AUTOMATIC RIFLE.

The following description of the Friberg rifle is from the *Tidskrift i Sjöväsendet:*

The idea of this rifle originated some years ago with Lieutenant Friberg, of the Swedish army, who has since died. The task was then taken up by Engineer Rudolph H. Kjellman, manager of the Stockholm Small-Arm Factory.

DESCRIPTION.

Externally the weapon resembles the Mauser rifle adopted by the Swedish army. The weight is the same, or even 100 grams (3.52 ounces) less. The barrel and the position of the cartridge are the same. The magazine is designed to contain five cartridges, which are introduced in the same manner as in the Mauser rifle, and the same kind of clip is used. There is nothing to prevent providing magazine space for ten cartridges or two packets.

The mechanism is actuated partly by the recoil, which at the same time bends a spring which returns the recoiled system to firing position, and partly by this return recoil.

During that part of the recoil which takes place before the bullet leaves the barrel the breech bolt is firmly connected to the barrel by the locking system and does not begin to open until after the bullet has left the muzzle.

The locking of the breech bolt to the barrel is perhaps the most important feature of the whole mechanism, because it furnishes at the same time an absolute guaranty against accidental discharges by the striking of the firing pin before the mechanism is entirely closed and renders it impossible for the mechanism to open unless the firing pin has been drawn back. This is due to the fact that the space between the locking lugs, which are situated exactly opposite each other, is, when they are in their locking position, entirely filled by the head of the firing pin, which must enter here in order that the point may be able to reach and strike the base of the cartridge.

The following is a list of the principal parts of this weapon. The numbers in the list and in the following description correspond to the numbers in the accompanying illustration:

1. Breech bolt.
2. Firing pin.
3. Head of firing pin.
4. Lugs of firing pin.
5. Firing-pin shoulder on mainspring.
6. Firing-pin notch.
7. Bolt handle.
8. Breech-bolt locking lugs.
9. Extractor.
10. Trigger pawl.
11. Trigger-pawl spring.
12. Nut of firing pin.
13. Mainspring.
14. Barrel.
15. Upper casing, with nut.
16. Downward shoulder of upper casing, with bearing for lever pivot (23) and fastening for rod of recoil spring (32).
17. Spring in upper casings for breech-bolt locking lugs.
18. Spring to hold cartridges in place in the magazine.
19. Cartridge guide.

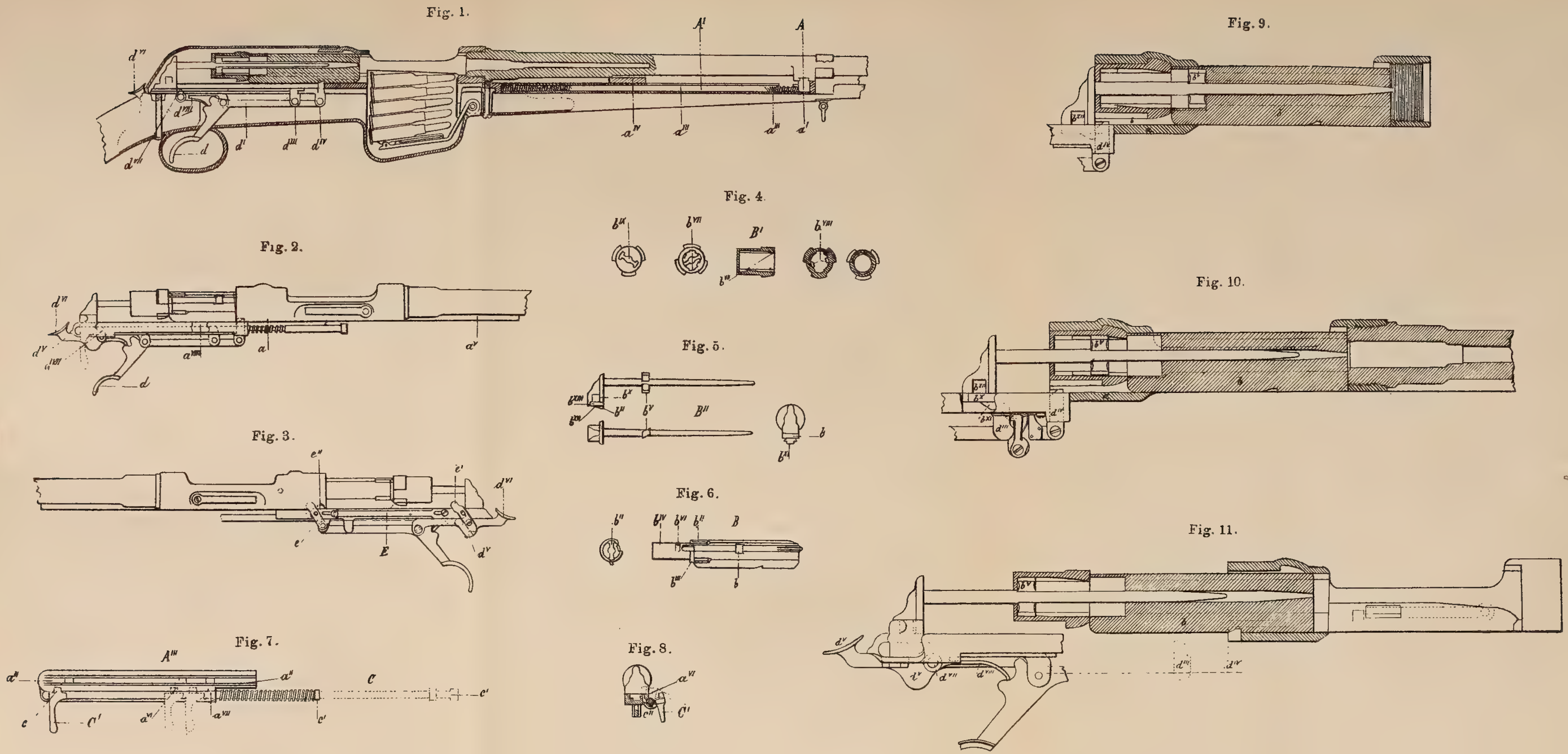


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.

THE FREDDI AUTOMATIC RIFLE.

20. Spring stop for breech bolt when magazine is empty.
21. Magazine spring.
22. Lever.
23. Lever pivot.
24. Ejector.
25. Lower casing.
26. Lower casing closing lug.
27. Lower casing opening lug.
28. Lock catch with spring.
29. Trigger catch.
30. Trigger.
31. Safety catch.
32. Recoil spring with rod.
33. Lock for holding together the forward and rear portions of the stock.

In the foregoing list, which is not complete, some of the parts not essential to an understanding of the description having been omitted, each separate part not only has been given a number, but wherever deemed expedient the different pieces of parts have also received independent numbers.

The breech bolt (1) is cylindrical and hollow throughout its entire length to receive the firing pin. In the upper part is a recess for the ejector (9). The ejector (9) is a flat spring. On the side the breech bolt has recesses for its locking lugs (8) and underneath a groove which runs along the greater part of the breech bolt. At the rear the breech bolt is threaded for the nut (12) of the firing pin. The rear projection of the nut is hollowed out in cup shape and serves to prevent the firing pin from turning.

The firing pin (2) consists of a head (3) with the striking point and a smaller cylindrical part, on which are to be noted the lugs (4) for the rear portion of the breech-bolt locking lugs (8), also the shoulder (5) for the mainspring, the firing-pin notch (6), and at the rear the handle (7), which is screwed on.

The breech-bolt locking lugs (8) have a square head, by means of which the lug enters its recess in the upper casing (15); back of the head is a rod which has a swelling in the middle. This swelling forms the center of movement of the lug. At the rear inner end of the rod is a lug against which lug (4) of the firing pin works, and at the rear outer end an elevation against which the springs (17) of the upper-casing locking lugs work.

The trigger pawl (10) is constantly kept pressed downward by its spring (11). It has at the top a rearward turned smooth surface by means of which it engages with the firing-pin notch (6), and at the bottom a notch in which engages the trigger catch (29).

The mainspring (13) is an ordinary spiral spring, which with its rear end strikes against the nut (12) of the firing pin and with its forward end against the firing-pin shoulder (5).

The barrel (14) is in every way similar to the barrel of the Swedish new 6.5-millimeter (0.26-inch) army rifle, and is screwed to the upper casing (15) by means of the casing nut. On the upper casing is to be noted the rear downward shoulder (16) with bearing for the lever pivot (23) and fastening for the recoil spring rod (32); in this shoulder works a small steel tooth which, when pushed upward, leaves a notch at the forward underside of the shoulder. There are further to be noted the walls of the magazine, with a recess partly for the fastening of the magazine spring (21), partly for the spring which helps to guide the cartridges, and also a recess for the springs of the breech-bolt locking lugs (17).

The cartridge guide (19) is in appearance essentially like that of the 6.5-millimeter (0.26-inch) carbine M/94, except that the high edge in the latter is cut off at the rear over about one-half its length, and in place of it is a stud (20) of the same shape as the edge. This stud sits on a spindle which enters that part of the edge which is not cut down, and is there controlled by a spiral spring, which returns the stud to the rear edge of the cartridge guide. This arrangement is designated as the breech-bolt stop.

The lever (22), which rotates around its pivot (23) and works with its upper end in the previously mentioned groove on the breech bolt, has its upper part split horizontally so as to form two arms, which turn separately around the smaller cylindrical part of the firing pin.

The cartridge-case ejector (24) is secured in the upper casing and has a tooth in the center.

The lower casing (25) forms the skeleton of the mechanism, so to speak, and is screwed to the rear portion of the stock. In it are two lugs which serve to work the lever (22), one (marked 26) for the closing of the mechanism and one (marked 27) for the opening of the mechanism.

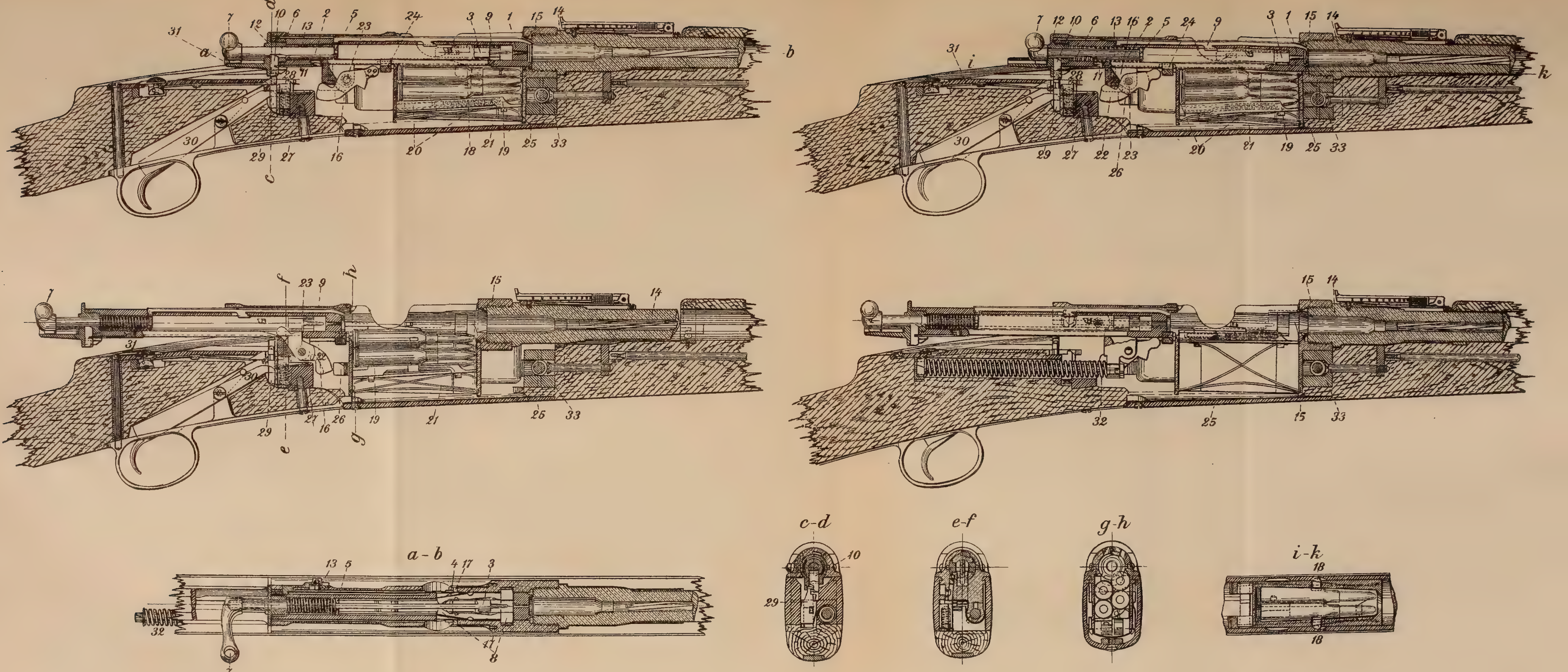
HOW THE MECHANISM WORKS.

The mechanism is assumed to be closed and ready for firing, the weapon loaded, and the cartridges in the magazine.

By depressing the trigger (30) the trigger catch (29) is actuated; it is drawn down and carries along with it the trigger pawl (10). The firing pin (2) thus becomes free to be impelled forward by the mainspring, and the shot is fired. Upon the recoil which follows, the upper casing slides backward until the shoulder (16) has well passed the lock catch (28). The latter is pressed down; but as its upper tooth strikes against the steel tooth in the shoulder the latter is pushed aside, and the lock catch thus forms a notch to work against.

By the rearward movement of the shoulder (16) the recoil spring has been compressed, and has now a tendency to move the upper casing forward. But this is still impeded by the lock catch (28). Simultaneously with the upper casing the lever (22) with its pivot (23) has also moved backward. When the lower arm of the lever receives the opening lug (27) of the lower casing, the lever is compelled to rotate around its axis. The upper part of the lever thus also makes a rearward movement relative to the upper casing, which is in motion. The arm forming the upper part of the lever now enters the groove in the breech bolt, and engages on either side the smaller cylindrical part of the firing pin, working against the forward side of its shoulder, and driving the firing pin backward relative to the upper casing and breech bolt. At this rearward movement of the firing pin, the head first leaves its position between the breech bolt locking lugs (8), thus giving it room to enter the breech bolt. As the firing pin continues to move, its lugs (4) strike the striking stud of the backward-going shanks of the locking lugs, driving it out and thus compelling the forward parts to enter, thereby rendering the breech bolt free to move back relative to the upper casing. Simultaneously the firing pin notch (6) has slid over the trigger pawl (10). As the breech bolt locking lugs release their hold in the upper casing, the upper part of the lever has also worked its way to the end of the groove in the breech bolt, and now forcibly strikes the breech bolt itself. This stroke serves to loosen the spent cartridge case, and impels the breech bolt with it downward. The remainder of the rearward motion of the breech bolt is effected partly by inertia, partly by the surplus tension of the main spring, which resumes its bent position. As the breech bolt moves backward, it carries the cartridge case with it until it strikes the lower edge of the ejector (24), where the cartridge case is thrown out.

The breech bolt has now reached its rearmost position, and a new cartridge is ready to be introduced. At the very end of its backward movement the breech bolt, through a lug on its underside, has struck the upper part of the steel tooth in



THE FRIBERG AUTOMATIC RIFLE.

the shoulder (16) and presses it downward. The steel tooth in its turn pushes the lock catch out of the way and thereby releases the upper casing, which is now driven forward into firing position by the recoil spring. During the forward movement of the casing the lower arm of the lever strikes against the closing lug (26) of the lower casing, whereupon the upper arm of the lever, working at the head (3) of the firing pin, drives the latter and the breech bolt forward relative to the upper casing, which also slides forward. The breech bolt thereupon pushes a new cartridge forward and introduces it into the cartridge chamber and takes its position for closing the mechanism. Before the breech bolt assumes this position the casing spring for the breech-bolt locking lugs (17) forces the rear shanks of the locking lugs into the breech bolt, whereby the forward parts of the locking lugs are forced outward into their recesses in the upper casing. If the lugs should not enter their recesses by reason of the breech bolt not sliding sufficiently forward, or for any other cause, the firing pin can not move forward, and thus no accidental discharge can occur. Nor can the locking lugs, if they should touch too high, as, for instance, in case of an abnormal shot, slide out of their tracks, that being prevented by the head of the firing pin, which, upon the firing of the mechanism, entirely fills the space between the inner surfaces of the forward parts of the locking lugs, and thus makes the upper casing and breech bolt, with the locking lugs, a rigid, immovable part.

The rifle is now ready to be fired.

The lock-catch arrangement (28) has been added in order to prevent the upper casing from beginning its forward movement before the breech bolt has entirely completed its rearward motion.

When the cartridges in the magazine are spent, the breech bolt in its forward movement strikes, in place of the cartridge, the spring stop (20) of the breech bolt. Thus far the breech bolt is controlled by the lever, for the stud moves forward and compresses the spring of the stop, but if by the end of the movement the inertia is sufficient for closing the mechanism, the stop checks the breech bolt and impels it back to the open position by means of the spring, as seen in the illustration, when there are no cartridges in the magazine. The mechanism has the same appearance also when opened by hand.

The operation of the safety catch (31) is such that when it moves forward it forces the trigger catch (29) aside and thus prevents it from engaging with the trigger pawl (10) and at the same time impedes the latter from moving downward.

The opening by hand is done by drawing the firing pin entirely back. This is somewhat more difficult than in the Mauser rifle, because the firing pin is cocked by this movement. The breech bolt slides forward into its place more easily.

By means of a simple locking arrangement the upper casing can be prevented from recoiling, in which case the automatic rifle works like an ordinary magazine rifle, with the advantage that the closing mechanism moves rectilinearly. The opening and closing of the mechanism can be effected without difficulty while the rifle is in the firing position, so that in case of a missfire during an automatic series the marksman need not take the rifle from his shoulder to remove the cartridge and get the weapon ready for another round.

This rifle has been tested, and after 1,000 rounds had been fired, the weapon showed no defects; the temperature of the barrel had risen to 120° C., but this appeared to have no detrimental effects and caused no danger of the cartridge being accidentally ignited.

In a series of 50 rounds, fired in three minutes by Lieutenant-Colonel Lemchen, director of the musketry school at Rosersberg, at a distance of 300 meters, at a regulation target, 46 hits were made.

THE CEI-RIGOTTI RIFLE.

This rifle has been recently described in the *Rivista di Artiglieria e Genio* as follows (see plates):

GENERAL DESCRIPTION.

This rifle is entirely automatic by reason of the action of the gas generated through the explosion of each cartridge.

At each discharge the gas opens and closes the breech, expels the empty cartridge case, and recharges the weapon, enabling the marksman to fire all the cartridges in the magazine without removing the rifle from his shoulder nor raising his eye from the target.

By alternately pressing and releasing the trigger each shot can be fired separately, while by turning an interrupting lever all the cartridges in the magazine are discharged in a few seconds and with the rapidity of the most rapid machine guns.

The handle of the obturator moves in a straight line, but when the cartridge is fired the cylinder, in revolving, is connected with the breech by two strong shoulders.

The magazine can be rapidly refilled with clips and is adapted to hold as many as 50 cartridges.

The apparatus for the utilization of gas consists of four parts, which are applicable to any rifle, either for war, hunting, or defensive purposes, as also to machine guns and revolvers.

The barrel, which has a sight graduated to 2,000 meters, carries a short bayonet.

The piston rod, which is divided into several parts screwing into each other, is entirely inclosed in the wooden stock of the rifle.

Opening and closing of breech.—The obturator is taken hold of and drawn back until it encounters the forelock which stops it.,

This motion extends the spring, whose object is to close the obturator again and enable the tooth of the heel piece of the spring to be raised in order firmly to hold the cylinder.

When the end of the trigger is depressed, the obturator again closes of itself.

Apparatus of the spring.—It consists of two teeth, which are close to each other, and which are alternately raised and lowered to stop the firing pin each time that the trigger is pressed or released.

Intermittent firing.—It is done simply by pressing and releasing the trigger.

Continuous firing.—It is done by bending the lever which restrains the left-hand tooth of the spring and pressing the trigger. The obturator then moves back and forth with such rapidity as to discharge 30 or more cartridges in a few seconds. When the firing is concluded, the magazine spring stops the obturator, and as the result the breech remains open.

Breech bolt.—It consists of an obturator sliding in the breech and a long handle which moves on the outside, always in a straight line.

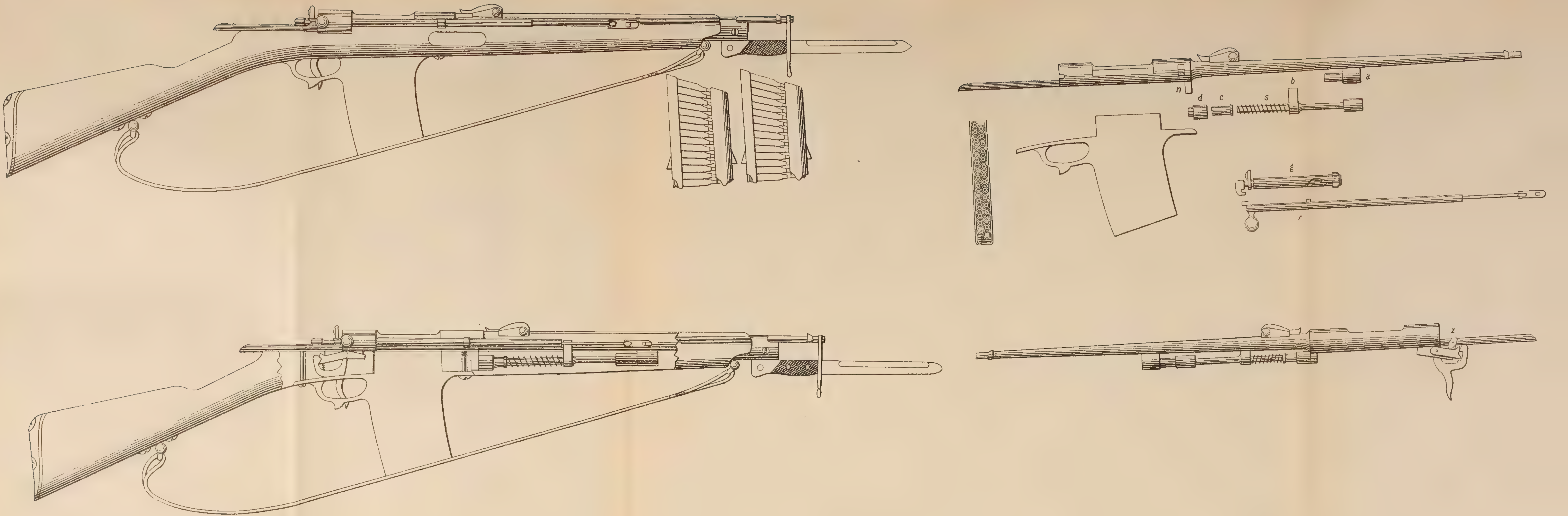
The cylinder contains the safety tube and the firing pin; the handle contains the spring which automatically closes the obturator.

Apparatus for the utilization of the gas.—It consists of four parts, covered by the wooden stock of the rifle.

The principal part is a piston rod which, surrounding a short vent receives the impulse of the gas and transmits it to the handle of the obturator.

Two small tubes complete the apparatus and serve to maintain the piston rod in a straight line.

Functioning.—While the projectile passes through the barrel, the gas, passing through a small hole inside the vent, impels the piston rod, which in its turn transmits the motion to the handle and compels the cylinder to rotate.



THE GEI-RIGOTTI RIFLE.

The obturator, no longer held to the breech by the shoulders, recedes, impelled by the empty cartridge case, and then closes again, thanks to the spring, introducing another cartridge into the barrel.

This arm is identical in dimensions and weight, except in the gas chamber, which is slightly heavier, with the new Italian small arm. The caliber is 6.5 mm. It is reported that at firing trials held at Rome, June 13, 1900, it was found that, while it was possible to fire 300 rounds a minute, the barrel, in spite of its thickness, became so hot that all further use of the weapon was precluded.

HOLLAND.

THE NEW RIFLE.

The following are the principal data of the new repeating rifle (modified Mannlicher type, model 1895) recently adopted for the Dutch army (*Rivista di Artiglieria e Genio*):

Weight of weapon with bayonet sword	kilograms	4.6
Weight of weapon without bayonet sword	do	4.3
Length of weapon with bayonet sword	meters	1.643
Length of weapon without bayonet sword	do	1.287
Caliber	millimeters	6.5
Length of barrel	do	790
Number of grooves		4
Diameter of bullet (hard lead with nickel-steel covering)	millimeters	6.7
Length of bullet	do	31.4
Weight of bullet	grams	10.15
Length of cartridge	millimeters	77.5
Weight of cartridge	grams	22.55
Weight of clip (for 5 cartridges)	do	10

Although somewhat delicate, this weapon answers every requirement, is of great precision, and has a maximum range of 2,000 meters.

FRANCE.

In France, Captain Daudeteau has designed a self-acting magazine rifle of 6.48 millimeter (0.254 inch) caliber. The magazine is so constructed that the soldier can replace singly any cartridge expended, so as to keep the magazine always full for an emergency. The arm is on the bolt principle; a patent device prevents any possibility of double loading; the sword bayonet slides vertically under the barrel. The piece is said to have a flat trajectory up to 600 meters, and such penetrating power that at 200 meters it pierces nearly half an inch of mild steel and 5 feet of fir.

This arm is being tried with the idea of replacing the Lebel.

The *Militär-Wochenblatt* has published the following table of different types of small arms in use in different countries and the kinds of powder employed with them.

In the table the countries are arranged in the order of dates when the respective small arms were adopted by them. It will be noted that there is a tendency toward decreasing the caliber.

Country.	Small arms adopted.	Caliber.	Powder.
		mm.	
Portugal	Kropatschek M/86[1]	8	Compressed black powder.
France	Lebel 86/93[2]	8	Smokeless powder in flakes.
Austria-Hungary	Mannlicher M/95[3]	8	Smokeless powder in disks.
Denmark	Krag-Jörgensen M/89	8	Smokeless powder in flakes, cylinders 2 mm. long.
Germany	Mauser M/88[4]	7.9	Smokeless powder in flakes.
Switzerland	Schmidt M/89–96	7.5	White smokeless powder, short cylinders.
England	Lee-Metford M/89–91 and Lee-Enfield M/95.	7.7	Cordite, thin yellowish-brown tubes 1½ cm. long.
Belgium	Mauser M/89	7.65	Smokeless powder in flakes.
Turkey	Mauser M/90	7.65	Do.
Chile	Mauser M/93	7	Do.
Brazil	do	7	Do.
Colombia	do	7	Do.
Uruguay	do	7	Do.
Bolivia	do	7	Do.
Transvaal	do	7	Do.
Orange Free State.	do	7	Do.
Mexico	do	7	Do.
Greece	Gras M/74[5]	11	Black powder.
Russia	"Three-line" arms M/91 (Mossin, Nagant).	7.62	Pyroxylin powder in flakes.
Italy	Mannlicher Carcano M/91	6.5	Smokeless ballistite in grains.[6]
Argentina	Mauser M/91	7.65	Smokeless powder in flakes.
Roumania	Mannlicher M/93	6.5	Smokeless powder, cup-shaped.
China	Mauser M/93[7]	7	Smokeless powder in flakes.
Spain	Mauser M/93	7	Do.
Holland	Mannlicher M/93	6.5	Smokeless powder, cup-shaped.
Norway	Krag-Jörgensen M/94	6.5	Smokeless powder in flakes (ballistite).
United States	Krag-Jörgensen M/92[8]	7.62	Smokeless powder in flakes.
	Lee M/93[9]	6	Do.
Sweden	Mauser M/96	6.5	Do.
Bulgaria	Mannlicher M/88	8	Smokeless powder in disks.
Servia	Mauser M/99	8	Smokeless powder in flakes.
Peru	Mauser M/91	7.65	Do.

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[1] The 6.5 Mannlicher and Mauser rifles are being tested.

[2] Trials of a new rifle have been going on for some time with great secrecy.

[3] M/95 is a modification of M/90 and is 840 grams lighter. Small arms of 6 mm., 5.5 mm., and 5 mm. are being tested.

[4] In 1900 was commenced the introduction of rifle '98, which differs from M/88 only in details of construction.

[5] Trials of new small arms, among them the Mauser, are now being conducted.

[6] Recently solenite has also been used.

[7] Besides other types.

[8] Used in the Army.

[9] Used in the Navy.

Upon an examination of the foregoing table, the preponderance of the Mauser weapon over all other types will at once become apparent. Of the 31 countries enumerated, 17, or more tnan one-half, use small arms invented by Mauser and made for the greater part in German factories. Five use the Austrian Mannlicher, three a weapon of the Krag-Jörgensen type, and five use different types.

As to the question of powder for the infantry, most of the countries have decided in favor of the smokeless gun-cotton powder in the shape of flakes; only a comparatively small number of States have adopted nitroglycerine powder.

The ballistic effects attained during trials have led to the very natural result that all powers using Mauser weapons (with straight rifling), which have proved the most effective and durable, have chosen a powder which brings out the full power of this weapon.

BALLISTICS.

The Wolf Air-Shock Indicator.—The German *Mutter Erde* publishes the following description of a new apparatus for determining the velocity of projectiles. This process has recently been adopted by many of the European nations.

NEW METHOD OF MEASURING THE VELOCITY OF PROJECTILES.

The determination of the velocity of projectiles of artillery has been carried on up to the present time in accordance with a method given by Wheatstone in 1840, which consists of stretching copper wires at a measured distance from each other, forming parts of the current of an electric chronograph, which are consecutively struck by the projectile. The time for the beginning of measuring the distance from the chronograph is registered by breaking the wire nearest the gun; the breaking of the most distant wire gives the signal for the end of this distance. The chronograph, therefore, registers the time of flight of the projectile for the given distance. The quotient of the length of this distance by the time consumed in the flight of the projectile is called the mean velocity for that distance, and it was agreed to designate it as the velocity for the distance of the center of the measured track from the muzzle of the gun. For instance, if the center is located 50 meters (164 feet) from the muzzle, and if the mean velocity, v, has been found to be 400 meters (1,312 feet), so is $v_{50}=400$ meters (1,312 feet). In order to make sure that the wires are always hit, they are spread in many windings to and fro on rectangular or quadratic frames, about 1.5 meters wide and 1.5 meters high (4.92 feet), the so-called lattice frames. (Fig. 1.) The distance of the windings from one another is about one-third the diameter of the projectile, so that, especially by projectiles of smaller caliber, a considerable number of wires is spread on the frame. The wire so spread has, in case of a 10-centimeter (3.94 inches) projectile, a length of about 80 meters (262 feet), and since its diameter is only 0.5 millimeter (0.02 inch), its resistance to the electric current will amount to 7 ohms. The resistance in the common chronograph also amounts to about 7 or 8 ohms, inclusive of the conducting wires for every circuit, and as the intensity used amounts to 1 ampère, an electro-magnetic force of 14 to 15 volts is required, necessitating from 8 to 9 Bunsen's elements. The resistance of the wire frames increases considerably with smaller calibers, because not only are the windings closer together, but it also becomes necessary to use thinner copper wires.

The torn wires must be replaced after each shot by new ones, which is done by simply twisting the wire ends together. It is clear that the deficiency of contact at the twisted parts, as well as the inequality of the stiffness of the newly streched wire ends, will seriously affect the resistance of the wire screen and also the intensity of the current of the chronograph, consequently the correctness of the registration.

According to experience, the disturbances are quite strong if not particularly experienced men are used for restringing the wire frames. If this, however, is done, very even and reliable measurements are obtained by these methods, provided chronographs are used, the probable errors of which, as against the errors in shooting, may be neglected, which is the case in the now commonly used Boulengé chronographs.

Notwithstanding the excellence of this method, it has some disadvantages, which during the time it has been in use could not be eliminated. It is, for instance, inconvenient that every time a different caliber is used it becomes necessary to substitute other wire screens, with different resistances, and, therefore, also the introduction of another number of elements in the circuit; and, further, that velocity recorders must be installed which correspond to the new conditions. Still more troublesome is the new restretching of a frame after every shot. At least one man must rush to the frame to make the necessary connections, whereby a certain amount of precious time is lost, since the manipulation requires a longer time than the charging and aiming of the gun.

It is principally for these reasons that this method now in use for more than fifty years, although useful and reliable, is gradually being banished from the ranges of target practice, and is being replaced by new ones not less reliable, which do away with the above-mentioned disadvantages.

A new method for the determination of the velocity of projectiles has been introduced through the discovery of Mach—that projectiles which develop a greater velocity than the traveling speed of sound (about 340 meters = 1,115 feet) create at their points a compression of air, the so-called "front wave." Mach himself, who was the first to find this front wave by means of photography, made use of its position in relation to the direction of the projectile to measure the velocity. Assuming, though not quite correctly, that the velocity of the front wave is equal to that of the normal sound wave, he put:

$$\text{Velocity of projectile} = \frac{\text{Velocity of sound}}{\sin x}$$

The angle x, which is formed by the wave surface of the front wave with the axis of the projectile, was measured by him from his photographs, and he could therefore compute the velocity of the projectile.

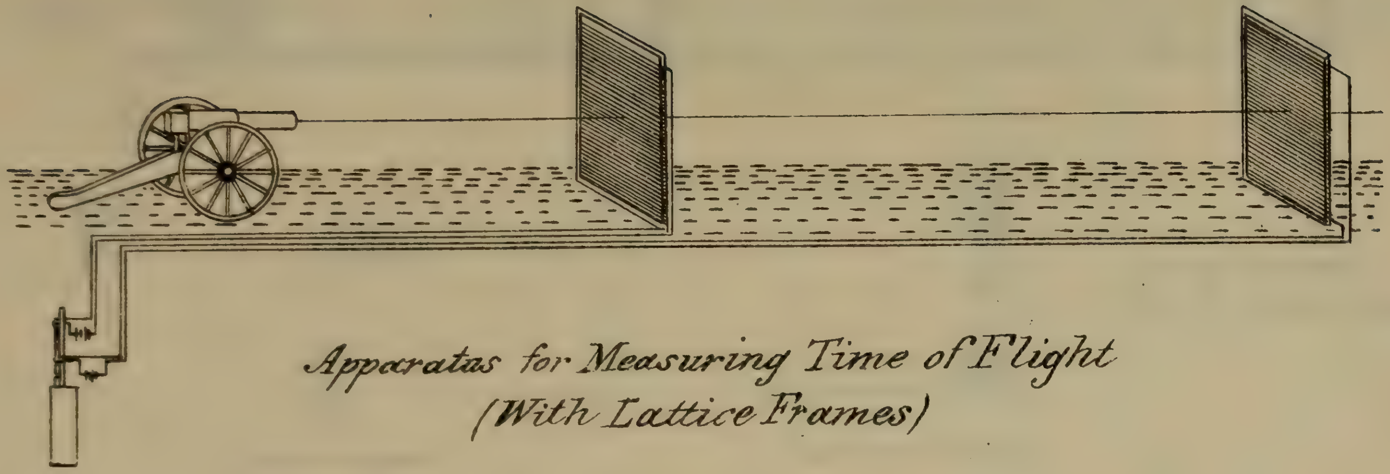
This method, on account of its being too cumbersome, is not adapted for practical purposes.

However, the idea presented itself to make use of the front wave created by the projectile for giving signals, if it should be strong enough.

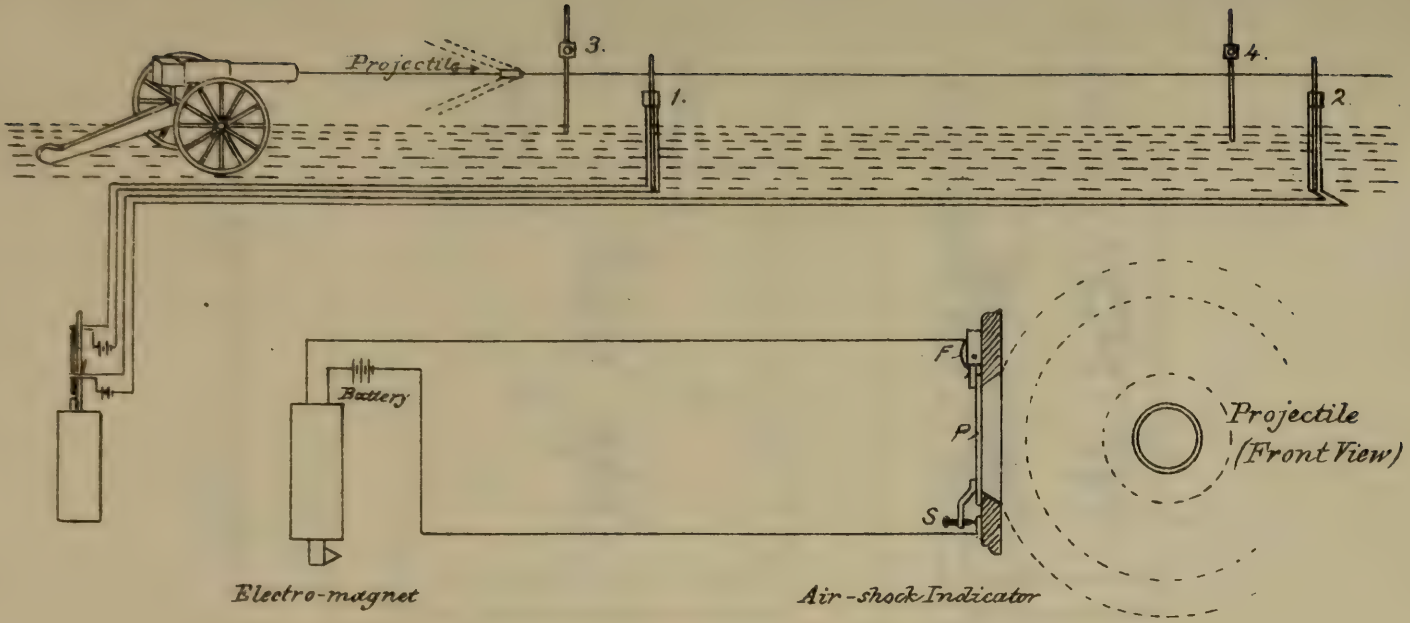
Experience has led to the knowledge that the front wave, which in its nature represents an impulse of sound, is sufficiently strong with calibers used by the artillery to perform noticeable mechanical work even at considerable distances. In consequence, an apparatus, the "air-shock indicator," was devised, whose construction dates back nine years, and the form of which is shown in figs. 2 and 3.

The air-shock indicators are automatically closing circuit breakers, which come into action as soon as they are struck by an air shock or a powerful impulse of front sound wave. The impulse is caught by a turnable rigid plate P (fig. 3), lying loosely in the crotch A, through the arm E, in which the contact screw S, with an attached platinum point, is inserted. When at rest, this platinum point lies firmly under the pressure of the spring F, against the contact plate C. This plate is in metallic connection with the attachment screw K_2, and the contact screw S, by way of P and A with the attachment screw K_1; besides, the contact places S and C, in order to prevent sparks on opening the electric current, are provided with layers of a condenser.

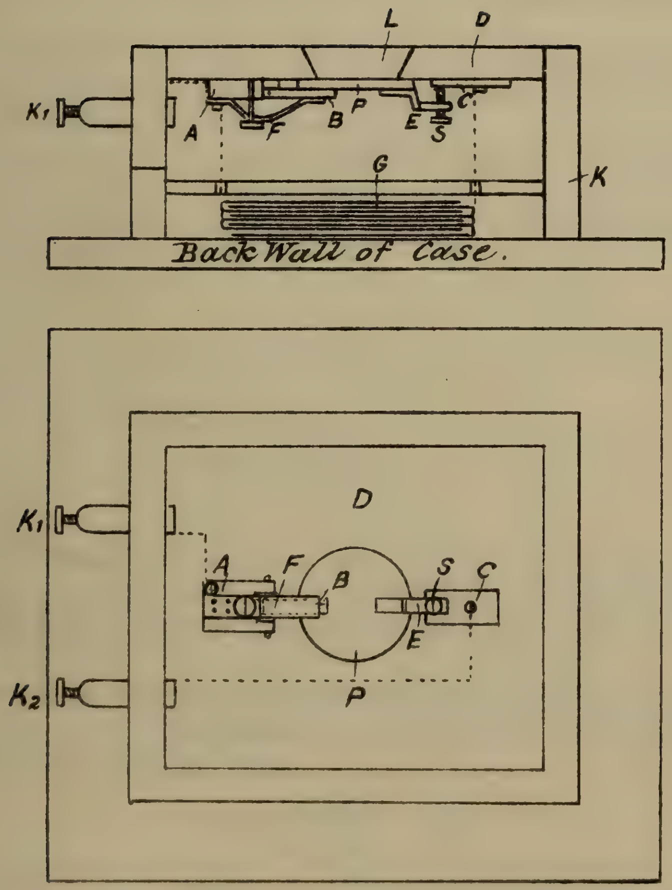
As soon as the front wave strikes the plate P of such an instrument, the contact screw S is thereby temporarily pushed away from the contact plate C, and thus interrupts an electric current running through the parts of contact, which, as soon as the influence of the impulse is passed, is immediately reestablished by the spring F.



Apparatus for Measuring Time of Flight
(With Lattice Frames)



Apparatus for Measuring Time of Flight
(Wolf Air-shock Indicator)



Wolf Air-shock Indicator.—

In measuring the velocity of projectiles two of these instruments are placed in front of the gun at known distances from one another, sideways of the flight plane of the projectile, and connected with the chronograph and the necessary galvanic batteries.

Since the working of the instruments is not caused by the projectile itself, it is necessary, in order to neutralize the retardation due to the fact that the front wave has first to travel from the point of the projectile to the plate P of the air-shock indicators, that the lateral distance of the two instruments from the flight plane of the projectile must be equal, so that the second instrument is affected in the same short fraction of time as the first. This is not difficult to accomplish. To avoid, however, any influence of a possible error in aiming, a pair of the air-shock indicators may be placed on each side of the flight plane, and the measurements made with two chronographs.

If, then, the four instruments are placed at the corners of a rectangle, even a considerable deviation of the exact direction of the projectile will not produce a perceptible error in the final result of the measurement.

If a represents the error in aiming, expressed in degrees, c the velocity of sound, v_1 the record of the chronograph placed on one side of the plane of flight, and v_1' the record of the measurement of that on the other side, the velocity of the projectile from observations on one side will be:

$$v = \frac{v_1 \cos a}{1 + \frac{v_1}{c} \sin a}$$

and from those on the other side:

$$v = \frac{v_1' \cos a}{1 - \frac{v_1'}{c} \sin a}$$

If the angle a is so small that $a=0$, and $\cos a=1$, the recording of both chronographs will be the same, and will indicate the actual velocity. If the readings of both chronographs do so correspond, the result proves, too, that there was no error in aiming.

Should the angle be known, which usually is not the case, then the true value can be computed from each of these equations. If not known, the combination of both equations is applied and expressed thus:

$$v = \frac{2\, v_1\, v_1'}{v_1' + v_1} \quad \cos a$$

Cos a can always be expressed as 1 in this formula, because an error of $a=2°$, which it is quite impossible to make, will only change the result 0.06 per cent. A velocity which is actually 600 meters would then be found to be 599.64 meters.

In practice, however, this formula will not be applied, because the greatest error that can be made in the aiming of the gun, without injury to instruments, can only amount to 40′, and an error of 4′ is rarely made. But even should it amount to 40′, the arithmetic mean of the two readings of the chronographs, measuring on both sides of the flight plane, may be taken, wherefore:

$$v = \frac{v_1 + v_1'}{2}$$

The error in the result will then amount to one-fortieth per cent, while with an error of aiming of 4′ the velocity measured on both sides will be at fault only about one-tenth per cent, and the arithmetic mean will show no deficiency in the second decimal place.

An exactness of one-tenth per cent is sufficient for all purposes, so that—provided the air-shock indicators are properly oriented in regard to the flight plane—the record of one pair of instruments will give sufficiently correct results.

A greater correctness can not be obtained by the use of the wire frames. In fact in rainy weather they are less reliable, because in that case the wire frames will be impregnated with water, thus disturbing the electric current, which disadvantage is avoided by the use of the air-shock indicators. The advantages of this method as against Wheatstone's are evident. The instruments give almost no resistance to the current, which in the wire frames may attain 50 ohms. As they are not acted upon by the projectile itself, but by impulse of sound waves emanating from it, they are independent of any caliber used in target practice, while with each caliber a corresponding wire frame must be used. As regards bullets of small arms, the impulse of the sound wave is not sufficiently strong, and therefore the instruments can not be used. But in this case the wire frame method likewise can not be made use of, and recourse must be had to other arrangements. Furthermore, since the air-shock indicators work automatically, which means that the contact after each shot is at once automatically reestablished, all the disadvantages which, as described above, the wire frames possess are eliminated. It is possible, therefore to record in the same period of time a double number of measurements for velocity if air-shock indicators are used, and in addition it is important to consider that the men necessary for the rewinding of the wire screens are here not needed.

These advantages have, consequently, in Germany and in other countries banished the wire screens from most all the artillery ranges, so that where the velocities of projectiles which exceed the velocity of the sound wave are measured, the air-shock indicators have been introduced. Fig. 2 shows how these instruments are used.

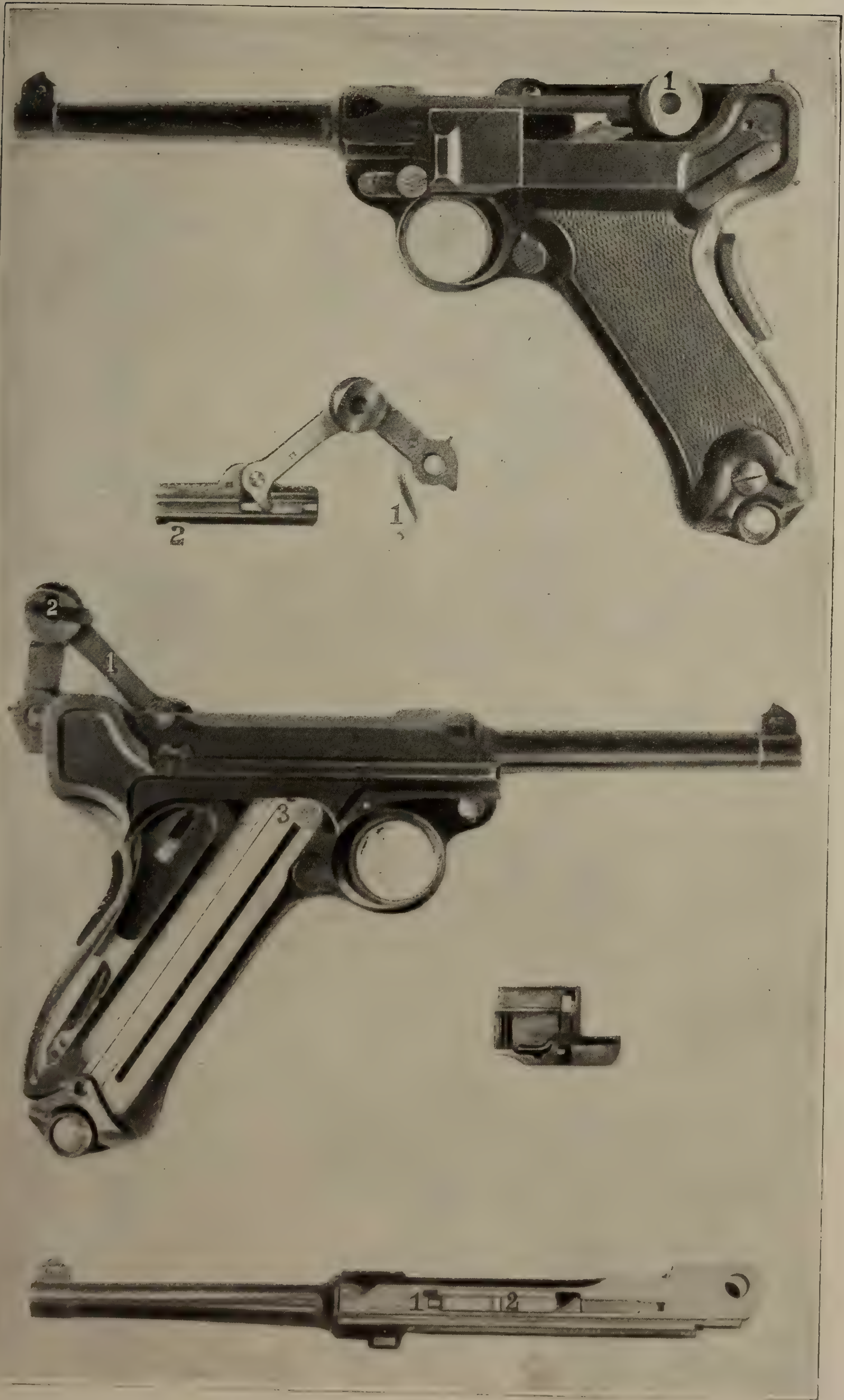
AUTOMATIC PISTOLS.

Although several inventions have appeared to adapt the recoil idea to the revolver, notably the Fosbery, it appears that revolvers are being finally displaced by the magazine pistol, at least for war purposes.

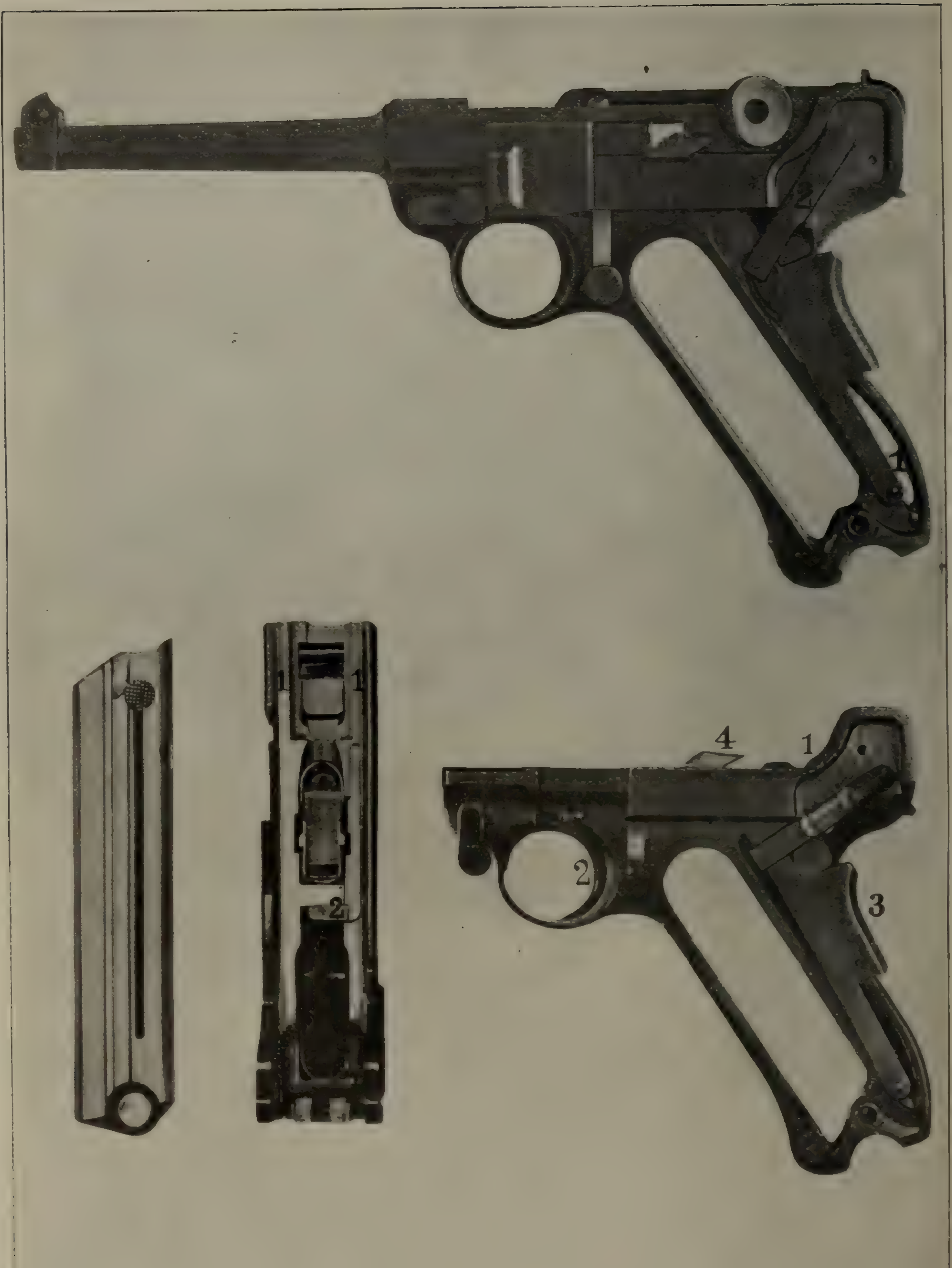
The German officers are armed with the self-loading Mauser pistol, heretofore described in No. XVIII of this series; but the Bergmann automatic pistol, model '97, is now under trial. The caliber of this arm is 7.65 millimeters (0.301 inch); it has a detachable magazine carrying 10, 20, or 30 cartridges, and has a case which, like the Mauser, forms a stock. At 20 meters it penetrates 11¾ inches of fir. It can fire 120 shots a minute and is of simple manufacture, easily dismounted and assembled.

THE BORCHARDT-LUGER PISTOL.

The Borchardt-Luger pistol, of which descriptions have appeared in the Swiss *Military Review*, is a repeating weapon, the discharge of gas being utilized to operate the mechanism, opening the breech, extracting and expelling the empty case, reloading and reclosing the breech for a new discharge. The firer has only to replenish the magazine and pull the trigger. This pistol, on competitive trial with other patents, fired 48 shots in 28 seconds, or 103 per minute. The arm showed great precision and continued firing without cleaning. The caliber is 7.65 millimeters (0.301 inch); length of barrel, 120 millimeters. At the moment of firing, the gas, acting on the base of the cartridge case, pushes back the barrel and the breech casing, which slide



BORCHARDT-LUGER AUTOMATIC PISTOL.



BORCHARDT-LUGER AUTOMATIC PISTOL.

along the grooves of the frame. During this movement the detachable breech and the barrel are firmly connected. The detachable breech follows the movement. The disks A of the knee piece bear against the butt pieces F_1, and start a circular motion of the link B_1, around the axis B_2. The knee piece rises up to the moment when the double spring C_1, contained in the butt, is totally compressed, the same as the percussion spring L_3. The cartridge case, pulled by the extractor L_1, strikes against the ejector, which expells it (the ejector projects out on the interior right wall of the breech casing).

The seat of the detachable breech being freed the top cartridge of the magazine, pushed by the interior spring, advances in front of the cylinder L_1. The double spring, compressed by the recoil, pushes the detachable breech forward sharply by means of the small chain K, which connects those two pieces. The knee piece is lowered one-half, communicating its motion to the breech casing and the barrel. At the same time the firing pin L_2 strikes against a stop projecting out on the interior left wall of the breech casing, and the percussion spring L_3 remains compressed.

The knee piece is completely lowered, the barrel and the detachable breech casing being again firmly held together. The arm is again loaded, closed, cocked, and ready to fire. On pressing the trigger F_2, by means of the elbow, G presses upon the extremity D of the piece D_2. The firing pin, being released, darts forward and strikes the cartridge.

After the firing of the last cartridge, the lug of the magazine B_3 presses a special spring, E_2, which projects in the frame and catches in the notch K_2 of the cylinder. The breech, instead of moving forward, is maintained in an elevated position in the rear, figure B. The line of sight being thus concealed notifies the shooter that the weapon is empty. This arrangement exists only in this pistol.

After the insertion of a fresh magazine in the butt, it is only necessary to pull the breech casing back a little (by seizing the disks A between the index finger and the thumb of the left hand) and let it move forward to have the weapon again ready for firing.

Automatic safety.—The kneepiece F_3 ends in a tongue, F_4, which rests against the right extremity of D_2. In this position the breech can not move back, the tongue resting against the projecting bevel of D_2. The pressure of the trigger can no longer act on D_1, and the tongue also prevents the piece D_2 from pivoting on its center. The arm is therefore perfectly secured.

In taking hold of the grip the hand presses upon the projecting part of the butt, the jointed kneepiece then pivots upon its inferior extremity, and the tongue is lowered. The movements of the breech and trigger are released.

Mechanical safety.—The little checkered lever C_2 being pushed from the bottom up hinges on its center. A small hook at its lower extremity is drawn under a slight buttress of the jointed piece. The pressure of the hand can not then act upon the mechanism of the automatic safety, which is rendered immovable. (Compare the position of the lever C_2 in figures F and C.)

THE COLT AUTOMATIC PISTOL.

This weapon was invented by Mr. J. M. Browning.

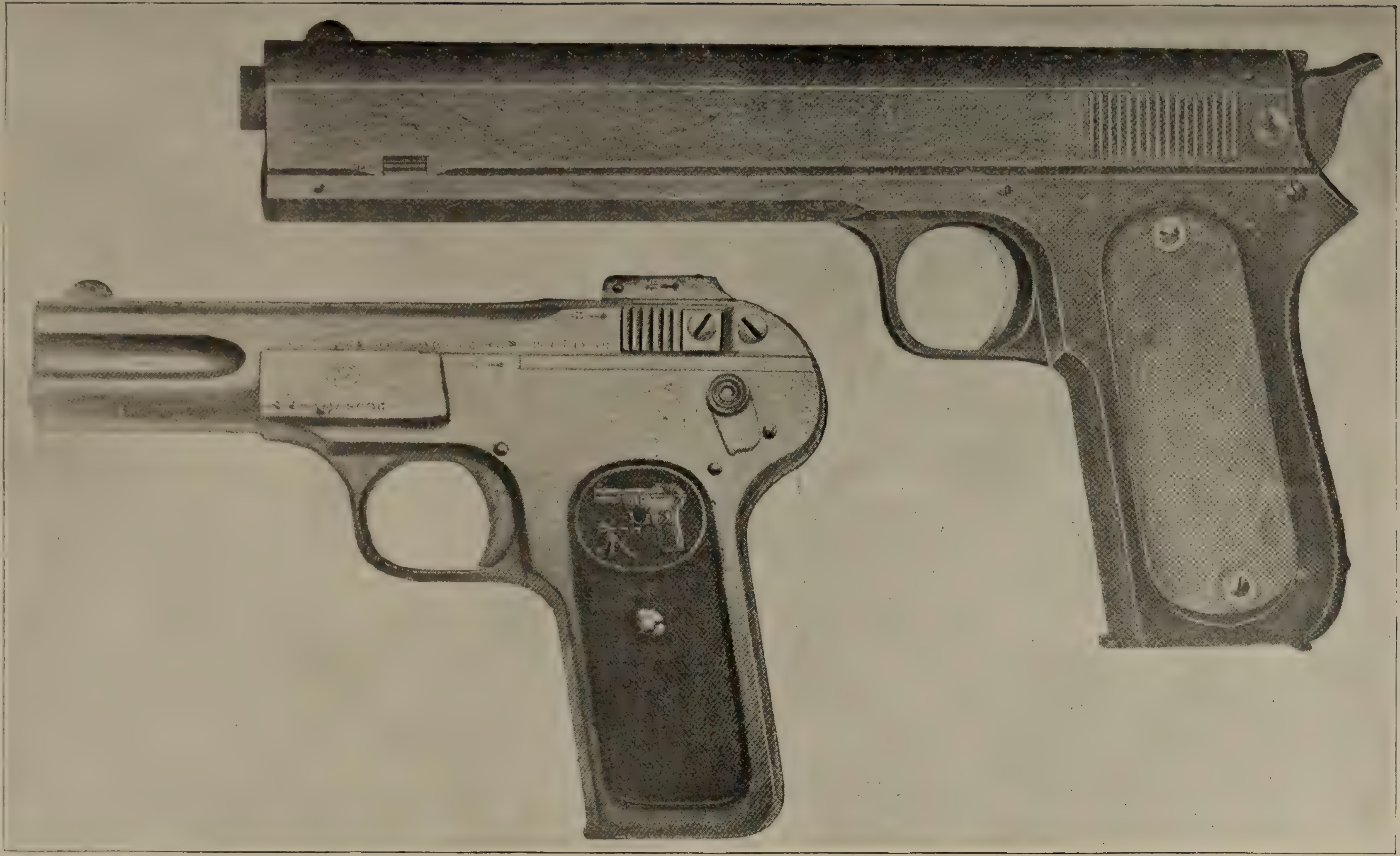
The piece consists of three principal parts: The frame, in which the trigger, hammer, mainspring, and magazine are contained; the barrel, which is secured to the frame by two links; and a sliding cover, which works in grooves on the sides of the frame, and which, in the firing position, is locked to the barrel by three ribs on the top of the latter, which fit into corresponding grooves in the slide.

The rear portion of the slide serves as a breechblock and supports the rear face of the cartridge.

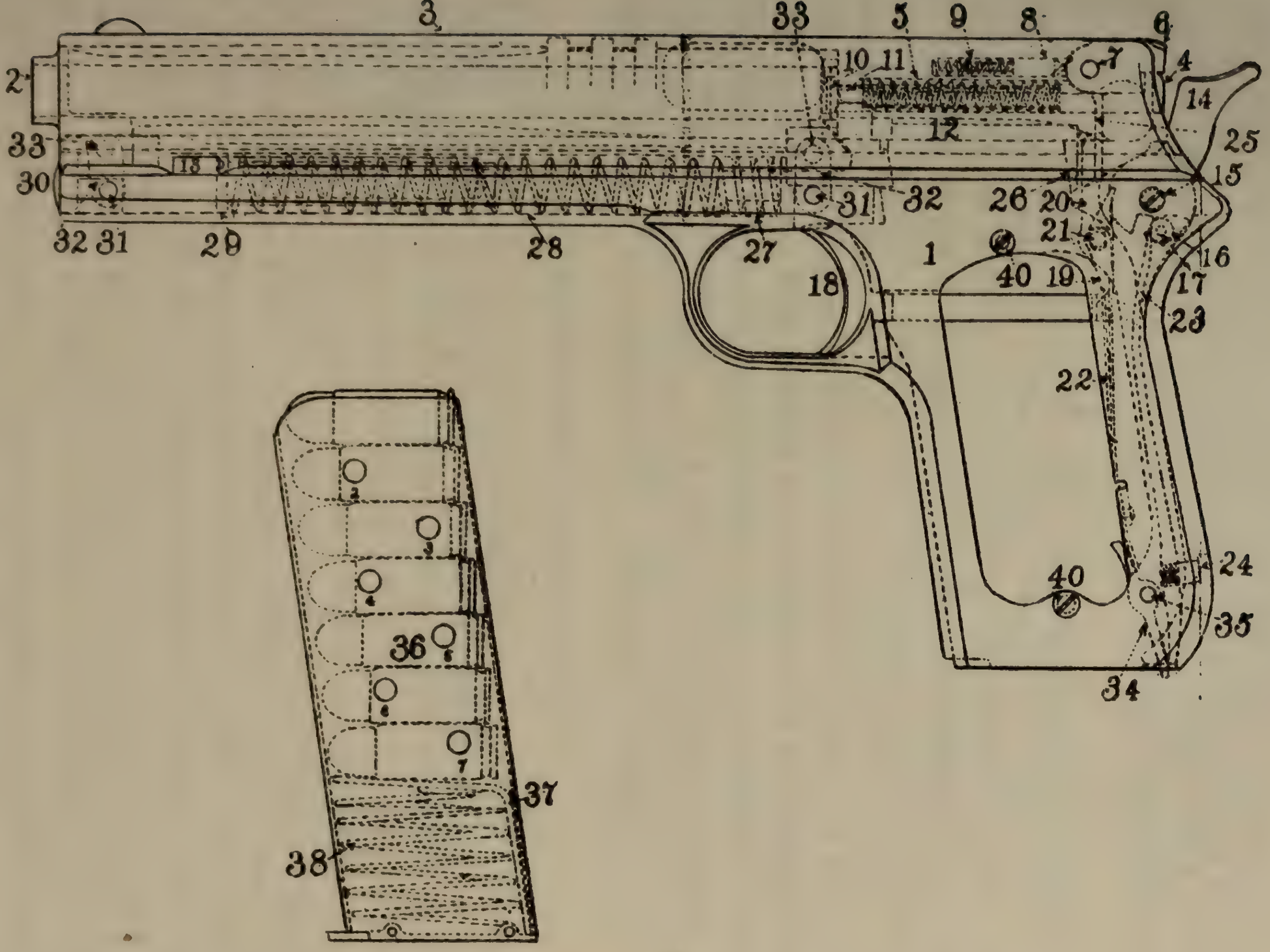
The caliber is 0.38-in. The barrel protrudes slightly in front, and is covered by the slide, which is capable of a backward motion, and which effects the necessary motions of cocking the arm, working the breech mechanism, and operating the supply of ammunition from the magazine. The magazine itself consists of a metal slide loaded into the stock of the pistol from below, and held in position by suitable clips, and in service it will be practicable to carry several of these magazines ready loaded.

To operate the pistol from the start it is first held in the left hand and the magazine is withdrawn from the stock by releasing a catch at the heel of the stock. The magazine is then loaded with its complement of seven cartridges, restored to its position, and the pistol transferred to its proper position in the right hand. The operation of loading the chamber and making ready to fire is accomplished by holding the slide with thumb and forefinger at the places provided with corrugations to prevent slipping, just over the stock, and pulling the slide back smartly. This movement cocks the hammer and the return action carries the top cartridge of the seven in the magazine forward into the chamber and closes the breech.

The pistol is now ready for use except the safety device known as the firing-pin lock, and constituting a rear sight, which must be raised. The safety being raised and one cartridge discharged, the force of the powder gases causes the slide and barrel to recoil together about two-tenths of an inch until the latter is stopped, drawn downward by the two links, and unlocked from the sliding cover, and the slide, still moving backward, cocks the hammer, ejects the empty shell sideways, and compresses the recoil spring. On reaching its rearmost position the slide is forced forward by means of a recoil spring, and encounters the second cartridge on its way, carrying it forward into the chamber of the barrel, the last part of its motion carrying the



COLT AND BROWNING PISTOLS.



THE COLT AUTOMATIC PISTOL.

barrel forward and upward. The slide now engages automatically with the barrel, and the arm is ready for a second shot.

Another safety device makes it impossible to release the hammer until the slide and barrel are properly interlocked in their forward position, and this device furthermore prevents the discharge of more than one cartridge for each pull of the trigger.

The weight of this weapon is 2 pounds 4 ounces; the length of barrel, 6 inches. It uses smokeless powder, 7.8 grains, with a 105-grain bullet, the velocity being 1,260 to 1,350 foot-seconds, with a penetration of 11 inches in American pine. The complete cartridge weighs 178 grains.

The arm is easily dismounted and assembled, and its construction allows of easy cleaning. The weapon has had a large sale in this country, and has recently, in the Browning form proper, been recommended and by royal decree ordered adopted instead of the Nagle in the Belgian army. The caliber of this pattern is 7.65 millimeters; it weighs 0.615 kilogram, and uses a cartridge of 7.85 grams. The weapon is manufactured at Herstal by the Government; it is said that 4,000 of them have been ordered for the officers of the Belgian army. This pistol has the following advantages: It is very simple in construction, is easy to operate, not liable to get out of order, is capable of a very high rate of fire, it gives a high initial velocity and flat trajectory. It has, however, a very light bullet which lacks stopping power.

THE MANNLICHER AUTOMATIC PISTOL.

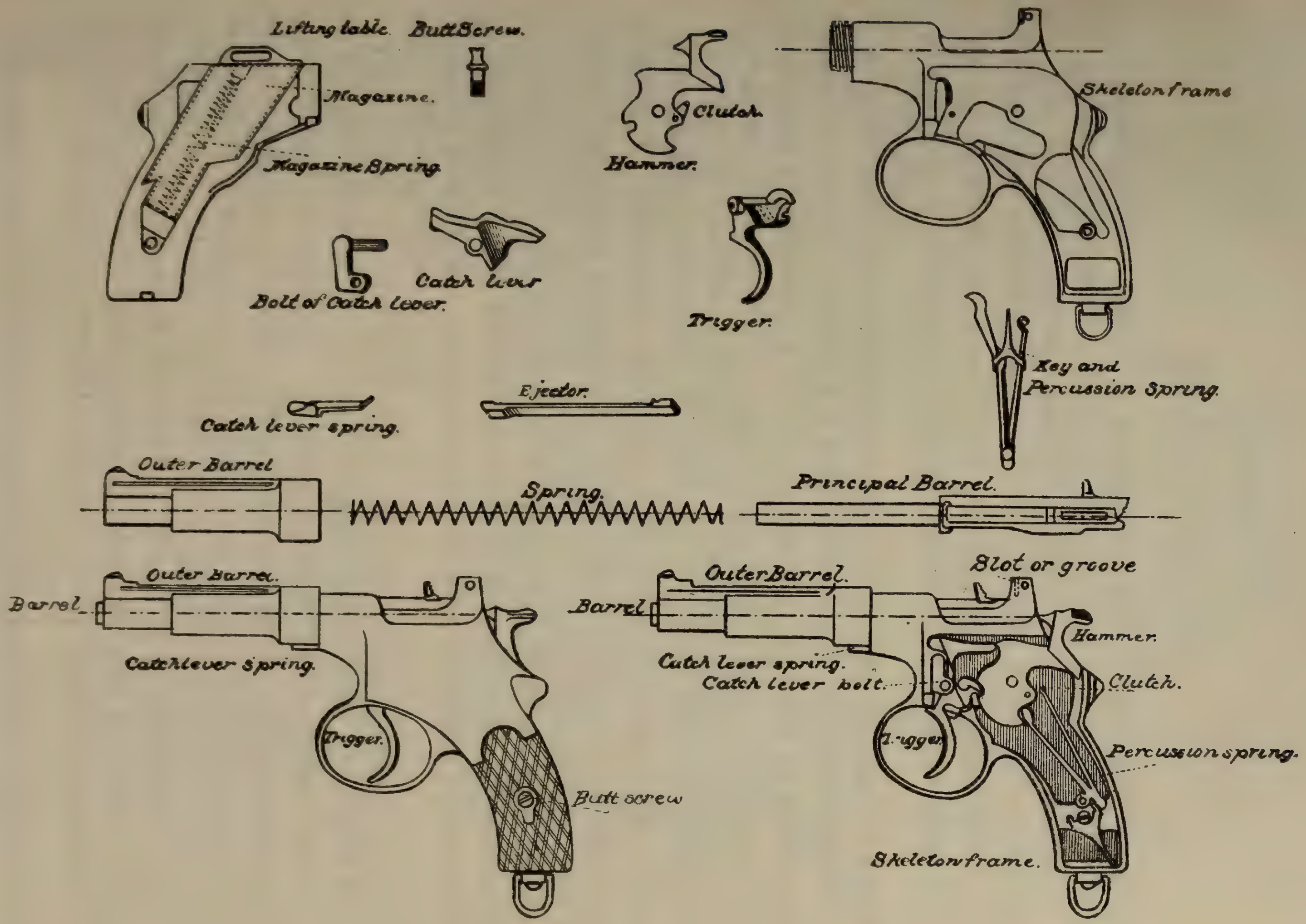
In this pistol the operations of loading and ejecting the empty cartridge case are performed by a backward and forward movement of the barrel. It consists of a frame which contains the lock mechanism and the magazine, a sliding barrel, and a cover or casing in which the barrel slides. The magazine, which holds five cartridges, is of the fixed-box type and is within the handle or stock. To fill the magazine, the barrel must be held in its forward position with one hand, while the cartridges are inserted singly with the other. When the magazine is full, the top cartridge is held in such position that the barrel, when allowed to go back to its firing position, slips over it, and the pistol is loaded, ready for firing. The lock operates in a manner similar to the lock of an ordinary double-action revolver. When the pistol is fired, the friction of the bullet as it passes through the bore carries the barrel forward against a spiral spring, where it is held by a stop, which continues to act until the trigger is released. The empty case is held to the rear by two ribs on the rear of the frame, which engage the rim of the cartridge case.

As the barrel approaches its extreme forward position, the extractor throws out the empty shell and allows another cartridge to come up from the magazine. When the trigger is released, the barrel spring forces the barrel back to its firing position over a fresh cartridge, and the pistol is again ready for firing. The caliber of this weapon is 7.6 millimeters; the weight, 2 pounds, 2 ounces; length of barrel, 7¼ inches; weight of cartridge, 171½ grains; number of cartridges in magazine, 5; weight of bullet, 112 grains; powder charge, 40 grains; velocity at 53 feet from muzzle, 798.6 feet per second; penetration at 25 yards, 6.3 inches of white pine.

To operate the weapon, it is loaded by bringing to full cock, pushing forward the barrel by the aid of the operating handle, placing the cartridge charger in the special groove of the magazine aperture, and loading the five cartridges into the magazine by a single pressure of the finger. Upon pressing the trigger once, then loaded as above, and then releasing it, one cartridge is thrown from the magazine into the barrel as it recoils, thus making the weapon ready for service; pressing a second time discharges the cartridge. This causes the barrel automatically to move forward, ejecting as it does so the empty shell, and upon its recoil it receives a fresh cartridge, which moves into position for firing.

This weapon has so far failed to fulfill required tests for acceptance, but it has many features desirable in a war arm.

Several adaptations of the recoil force to revolvers have been made to render them automatic, one of which is the Fosbery invention, of England. The automatic action of this revolver is obtained by allowing the barrel and chamber to recoil a short distance in a slide, this motion being utilized by means of a fixed stud engaging in the diagonal grooves cut on the exterior of the chamber to revolve the cylinder. The recoil automatically revolves the cylinder and brings the lock to full cock, leaving the shooter merely to take aim and press the trigger.



THE MANNLICHER AUTOMATIC PISTOL.

SECTION III.

FIELD GUNS.

According to the views of a noted German expert, the development of modern rapid-fire guns for field artillery is the most important problem confronting the military authorities of all countries. It is said that the British forces in South Africa were on some occasions attacked at ranges of over 11,000 yards, and with some effect, so that the question of fieldpieces of great accuracy on extreme ranges is held to be important.

A great foreign field-artillery maker said recently that his great aim at present was to construct a field-piece which at 10,000 yards would be capable of attaining a very rapid rate of fire and of placing all the rounds within a 10-meter square; the gun, after recoiling, to return exactly to its position, so that little or no sighting should be necessary.

The studies undertaken in Europe to fulfill these conditions have resulted in numerous solutions. Every nation has either recently changed or is now changing its field-piece. It was at the time thought remarkable that the Boers should have been so well armed, but when war was imminent they purchased extensively in Europe. They bought in England a small number of Maxim 75-millimeter (2.95-in.) rapid-fire field guns and a large number of 37-millimeter (1.45-in.) automatic Maxims (pom-poms).

They bought in Germany some old pattern mountain guns (Krupp), 68.8 millimeters (2.7-in.), some 75-millimeter (2.95-in.) rapid-fire field guns, some 37-millimeter (1.45-in.) rapid-fire mountain guns, some 12-centimeter (4.7-in.) field howitzers, and some 15.5-centimeter (6-in.) siege guns. The Orange Free Staters had some 75-millimeter (2.95-in.) Krupp guns. Of these guns but two proved themselves remarkably efficient in the hands of the Boers. The 6-in. guns proved too heavy for transportation and the fuses of others proved defective. It is said that the Krupp fuse proved to be the most perfect instrument of its kind.

The most heard of field-piece, and one which seems to have remarkably demonstrated its efficiency, has been the so-called "pom-pom." This piece is the 37-millimeter (1-pounder) Maxim automatic gun, using metallic cartridges similar to those used in small arms, but of a caliber of 1.45 inches, throwing a shell weighing 1 pound. This is not a very recent gun, however, though its unexampled success warrants a slight description to recall its characteristics to mind. The cartridges are placed in a looped belt attached to the gun. By a simple operation one of the cartridges is inserted in the barrel and is fired by pulling the trigger. After this the force of recoil is utilized to continue the firing automatically as long as the belts with cartridges are supplied.

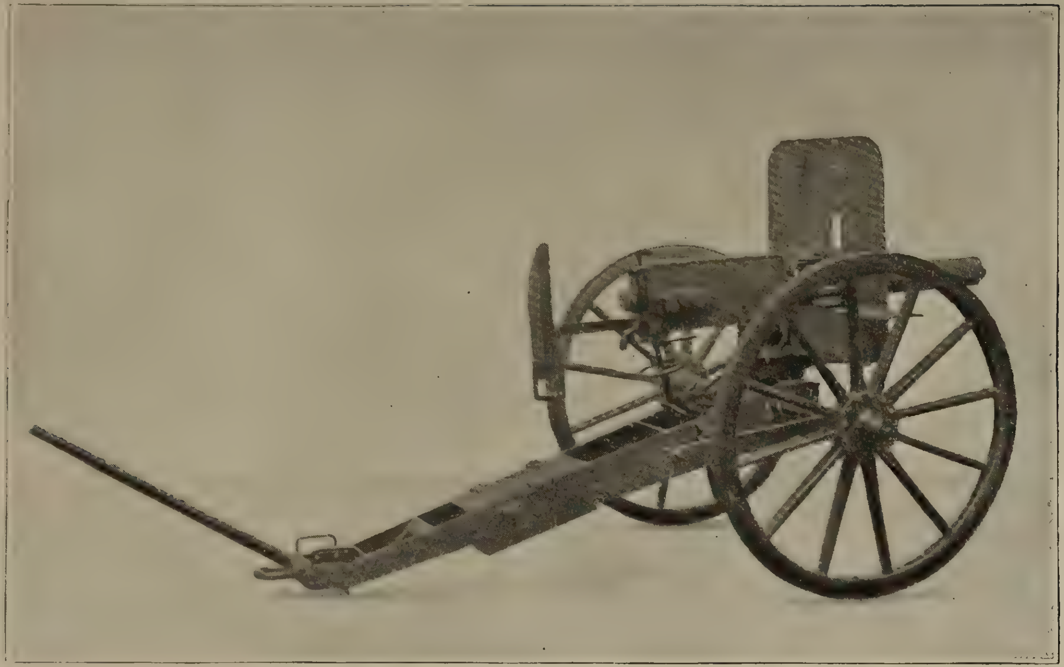
The first guns of this lot fired at the rate of about 400 a minute, but certain alterations were made which reduced the speed to 300 rounds a minute. In this gun the recoil of the barrel and its attachments at the instant of firing performs all the functions of extracting the empty cartridge case, opening the breech, cocking the hammer, bringing a new cartridge into position, thrusting it into the barrel, closing the breech, and pulling the trigger. This principle has been applied to the calibers up to 14-pounders, but as semi-automatic, a hopper being supplied in place of the belt, which was found to be unsuitable. In the 6, 9, and 14-pounders, the recoil after firing opens the breech, throws out the empty case; the loader then shoves in another cartridge, which automatically closes the breech and cocks the mechanism ready for refiring. The 1 and 3-pounders are automatic.

THE BOER FIELD GUN.

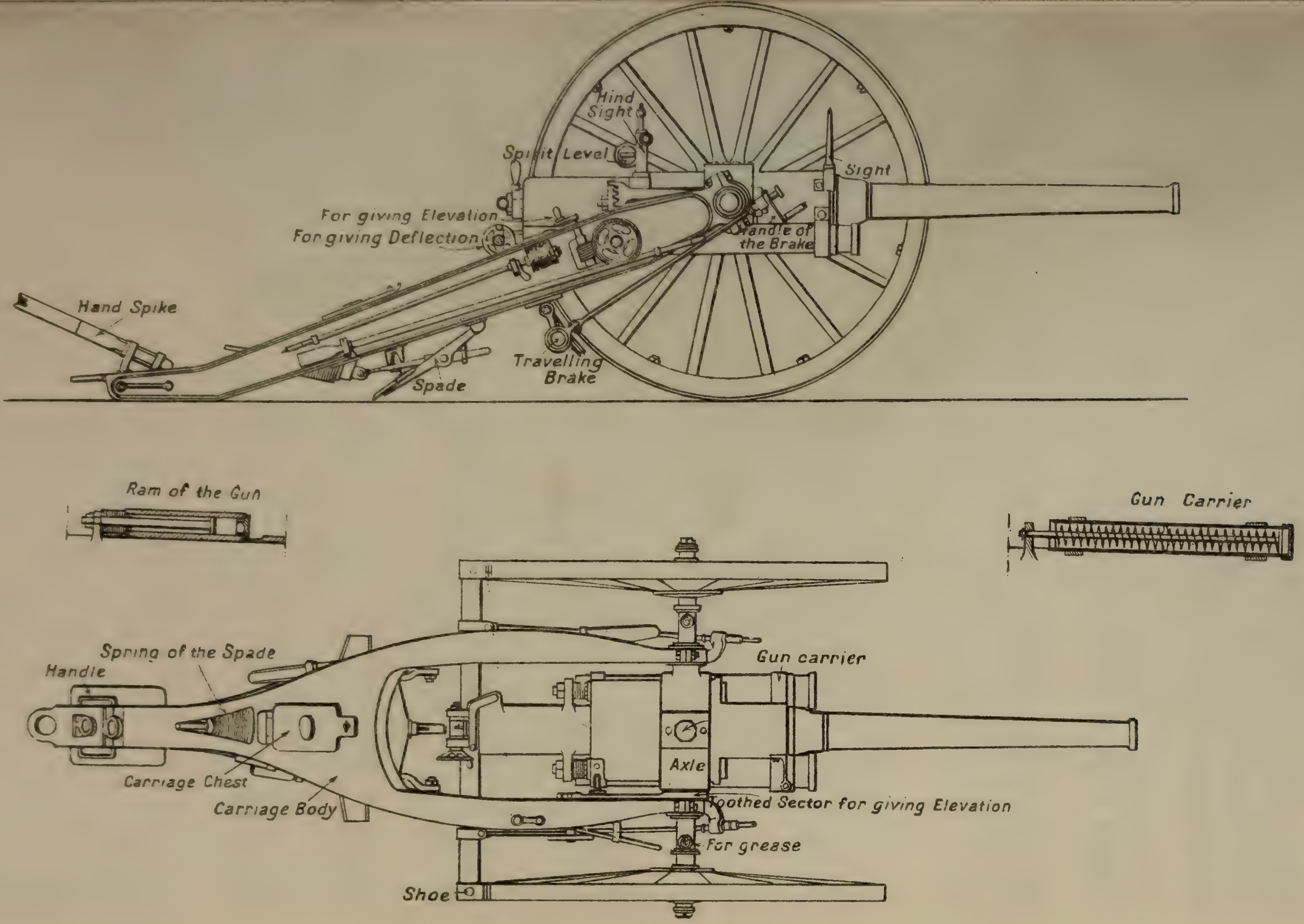
This is a French gun. The caliber is 75 millimeters (2.95-in.). There are no trunnions, but ridges are formed on the rear covering which slide in the cradle on the carriage. Various projections serve to attach it to the hydraulic rams which check the recoil, and two others are secured to strong spiral springs to shove the gun back into position after firing. A central lower projection is for the attachment of the deflection gear, by which the gun can be pointed laterally through a small angle without moving the carriage. A sight plane on the breech for the quadrant is provided for use when firing at long ranges and when the target can not be seen.

The breech mechanism is the interrupted screw for use with fixed, quick-firing ammunition in brass cases; it has an automatic extractor and firing pin. The rifling has 24 grooves.

The cradle in which the gun slides is pivoted to the axle-tree of the carriage and is elevated or depressed by means of toothed sectors worked by handle and worm. The cradle also carries the two ram cylinders filled with glycerine, which check the recoil, and the two gun carriers which force the gun back to the forward position. The recoil of the whole carriage is prevented by means of the spade, which can be let down and digs into the ground when the gun is fired, and a strong spring sends the carriage forward again after firing. The spade is fastened up out of the way for traveling. The brake can be used to check recoil on hard ground or rocky ground, when the spade would not act. The fore sight and the holder for the rear sight are both removable and are kept in position by springs. The rear sight



A "POM-POM," OR ONE-POUNDER MAXIM GUN.



BOER FIELD GUN AND CARRIAGE

is raised by means of a rack and pinion and has a deflection leaf, and a spirit level as an aid to rapid laying when the sight is fixed.

For indirect firing a serviceable and strong quadrant is used, which reads to minutes by a simple device of moving a runner along the radius bar. If the object or line of fire can be seen, the direction is obtained by means of a plumb line, but if not, the direction scale is used.

The projectiles are shrapnel, common shell, and case shell. The fuses are a time and percussion fuse, called by the Dutch a double-working fuse.

The fire composition channel consists of a long lead tube filled with composition, wound spirally near the outside of the coned ring; by this means a delicate adjustment and long time of burning can be obtained.

THE EHRHARDT FIELD GUN.

The British Government, profiting by their experiences in the South African war, are rapidly pushing forward their scheme for re-arming the artillery. They have ordered 120 of the new rapid-fire Ehrhardt and about the same number of the latest Elswick field guns.

These guns are of two calibers—the 14-pounder, which fires a projectile slightly under 3 inches in diameter, and the other, which carries a projectile slightly over 3 inches.

The gun is, approximately, 7 feet 6 inches long; 30 calibers; 3 inches clear in the bore; 28 shallow grooves, and is very slightly chambered out at the breech. It is said to be of nickel steel, Ehrhardt process, tube, and jacket.

The weight of the gun is 8½ hundredweight; the carriage represents 10¾ hundredweight, and the limber, with its complement of 32 rounds of ammunition, about 15 hundredweight. There is also an ammunition cart carrying 100 rounds and weighing a ton and a half.

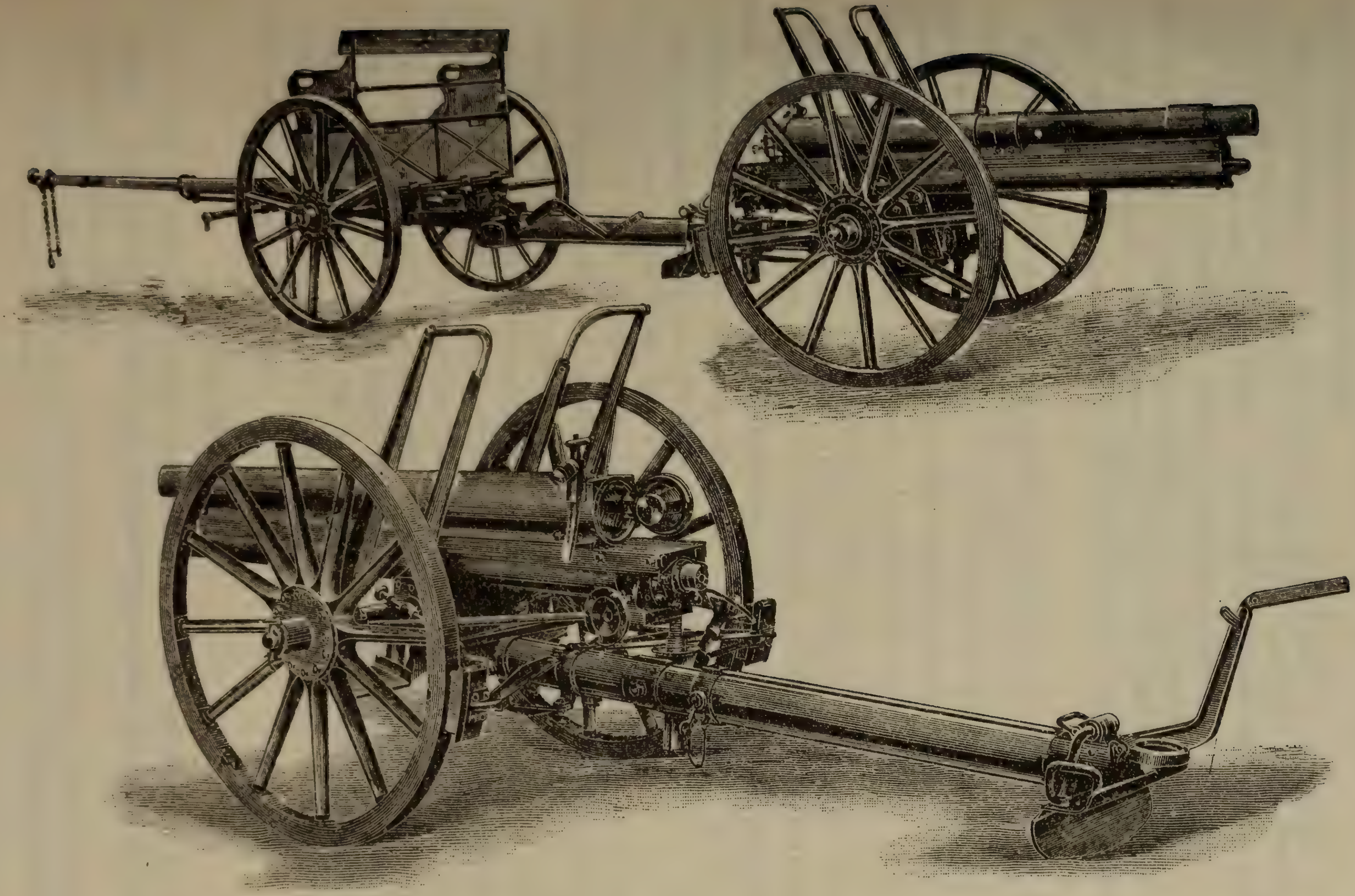
The ballistic energy of this gun is good. A projectile weighing about 14 pounds is discharged at a velocity of 1,740 feet per second. At 3,300 yards the velocity diminishes to 965 feet per second. With the larger gun greater velocity is attained, resulting in a flatter trajectory and greater accuracy. The rapidity of fire is about 16 shots per minute.

It is considered that the greatest effect obtained with this gun is in using shrapnel. The Ehrhardt shrapnel is bored out of white-hot special steel, and then drawn through successive narrow rings to toughen the metal and to render it more elastic with comparative lightness. Each shrapnel is filled with 300 hard, polished lead bullets, each weighing about a third of an ounce. There are also two shells, one with thin walls and a large charge of high explosive for mine effect, and another of thicker walls and smaller bursting charge. The projectiles are stowed in rattan baskets and sheet-steel chests. The fuses are of aluminum alloy and double acting; are regulated by hand without any mechanical assistance, the burning period being twenty-one seconds, sufficient to make them effective at a range of about 6,560 yards. It is claimed that the maximum rapidity of fire with shrapnel would concentrate a ceaseless stream of 5,000 bullets a minute upon any desired area. These guns are sighted up to 16 degrees elevation, which gives them a range of 8,000 yards with great accuracy. The gun differs from the existing types in the use of strong, seamless steel tubes, which are manufactured by a special process, instead of using solid metal for the carriage and mountings, thus giving a minimum of weight with a maximum of strength.

The short service trial of these pieces with the British artillery has developed that the mountings are altogether unequal to the strain brought upon them during the absorption of the shock of recoil. The absorption itself has been perfect, but the effect of its action upon the carriage is most disastrous: axletrees have doubled up and split into fragments, the majority of the fragments being at the center, where the central pivot of the gun bed passes through; the wheels also have developed decided signs of weakness, and many carriages have had to be sent to Woolwich for repair. There has been a decided escape of gas at the breech, but this can be remedied. These defects are due to manufacture and not to the nature of the gun.

The gun is not capable of quick dismounting in its present design.

The energy of recoil is absorbed by a hydraulic brake. There are two powerful rings shrunk on the body of the gun, one of which is close to the muzzle and the other not quite halfway between the muzzle and the breech. These bands are associated with seatings and slides which run easily backward and forward within ways formed by the steel edges of the trough, which is beneath the gun, and of similar length. Within the trough is a quadruple spring in five lengths, so that there are twenty springs in all, connected by washers with hollows, one on either side. The springs surround a hydraulic recoil cylinder, also necessarily within the trough and almost as long. Within the cylinder is a piston pierced with holes, working backward and forward in a bath of glycerine, and having its piston-rod head secured to the front end of the trough. The recoil cylinder is secured in front to a plate projecting downward from the forward gun ring and slide, before alluded to, and the piston rod passes through this plate. Thus, when the gun recoils, the projecting plate carries back the recoil cylinder along the piston rod, forcing the glycerine through the holes in the piston, and at the same time compressing the springs against the rear end of the trough. The recoil varies from 37 inches to 47 inches, but the average run back of the gun is about 41 inches, or about half the length of the recoil cylinder. This arrangement is sufficient to absorb all the energy of the recoil of the gun at any angle of elevation up to 16 degrees.



THE EHRHARDT FIELD GUN IN USE IN BRITISH ARMY.

The action of the springs is perfectly uniform, the hollow washers between the five sets sliding backward and forward within the steel trough, which they fit precisely.

The breech gear of the new guns is very simple and strong, the lever being upright, as in the recent Elswick examples, and opening the breech by a single movement. Instead of a screw half coned and half cylindrical, its shape is that of a truncated cone. The extractor is actuated by two wedge-shaped projections close to the hinge of the breech piece, which engage with similar movable projections on the right side of the gun, forcing out the extractor with considerable energy.

There is a wedge-shaped steel head at the end of the firing lanyard, which forces back the spring of the striker by the action of the wedge against it, and letting it go with a jerk directly the thick end passes a shoulder in the same. A stud beneath turns the gear from "safety" to the "firing position" at will. An excellent contrivance at the extremity of the striker may prevent many an accident: a rebound spring, attached to a loose sleeve at the end of the striker, brings back the point well within the face of the breechblock after the striker has been forced forward by the mainspring, so that the normal position of the point, even after the gun has been loaded, is within the face. Many a premature fire has occurred through the projection of a firing pin, when very rapid firing is going on.

The trail of this gun is cylindrical and of ordinary length in its normal condition, but by holding the hinged handspike firmly and getting the gun run forward at the wheels, the trail telescopes out until it is double its ordinary length. At the end is a wide and powerful spade, and from this, at ordinary elevations, say 6 or 7 degrees, the elongated trail is almost in the direction of the gun itself, the line of recoil being exactly in a line with the trail, which is rigidly secured by the spade. This small angle eliminates jump. There is also an ordinary steel brake, with a hand wheel to work it, which completely locks the wheels of the gun. This trail is shortened on the march and lengthened out for firing.

THE SWISS FIELD GUN.

It is said that the Swiss Gun Committee, after an exhaustive series of trials, rejected the Creusot and Ehrhardt guns and adopted a Krupp gun with a Swiss carriage.

The caliber of this piece is 75-millimeters (2.95-in.), has a length of 30 calibers, and is made of nickel steel; it has 28 right-handed grooves.

The gun itself is composed of a tube and rear jacket. At the rear, the jacket is prolonged beyond the tube to form the breech. The entire left part of this extension is cut away to admit loading. The breech sleeve carries at the right a sleeve for the sight. The trunnions, perpendicular to the axis of the gun, are cast in one piece with the jacket; on the right trunnion is the front-sight mass, into which the front sight is screwed. The chase of the gun ends in a slight swell of the muzzle. The rear is a curved sight, with level of the Corrodi plan. The sleeve of the sight is slightly inclined, to compensate for the drift. A flat breech wedge, Leitwell system, closes the breech; it opens to the right, facilitating the loading, which is done from the left. The gas-checking is accomplished by the metallic rim of the cartridge case.

The lanyard is hung before the first shot and during the firing to the eye of the firing spring of the trigger at the front of the block. The trigger is a repeater; that is, it can be recocked in case of missfire without opening the breech. The spring of the firing pin is not armed until just before firing. An extractor in the breechblock automatically ejects the cartridge case upon opening the breech.

The breech opens and closes in one motion. A hand safety catch is attached to the block which keeps the piece, though loaded, from being fired, or the breech from being opened, so that the piece can be safely moved, loaded.

The carriage is a rigid, trail-spade, spring-return carriage. The brackets of angle steel are joined about the middle of their length by a transom to which is attached the rod of the Belleville spring shaft from the spade, and this is attached at the other end to the trail by a broad curved plate forming a shoe, and provided at the rear with a lashing ring. The spring is compressed by the recoil, and its expansion, after the recoil is spent, carries the gun back to the firing position. The lower part of the carriage is rigid.

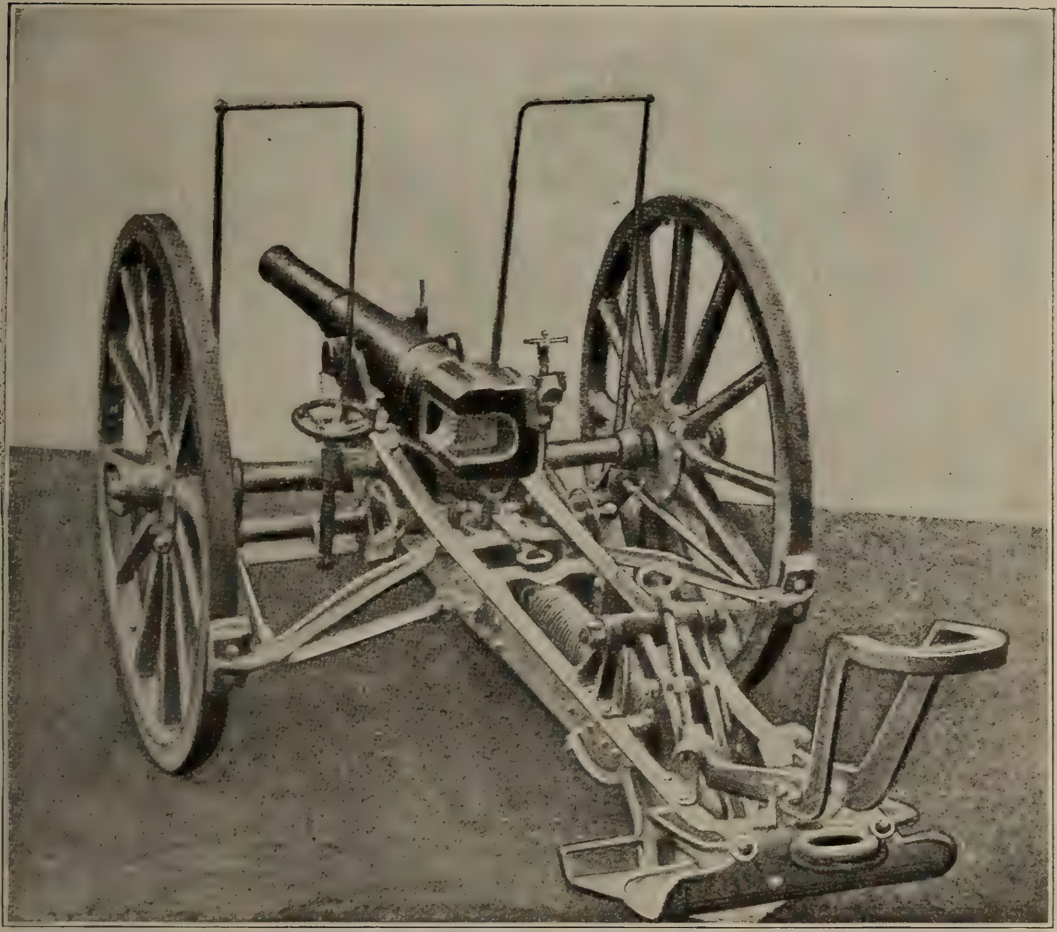
The gun rests on the carriage by means of a little mount pivoting around a vertical axis and susceptible of a lateral train of 3 degree each side of the axis. This movement is controlled by a handwheel on the left of the mount. A handwheel at the right serves for the elevation. The carriage has a footstep and two support frames for the gunners standing on the step.

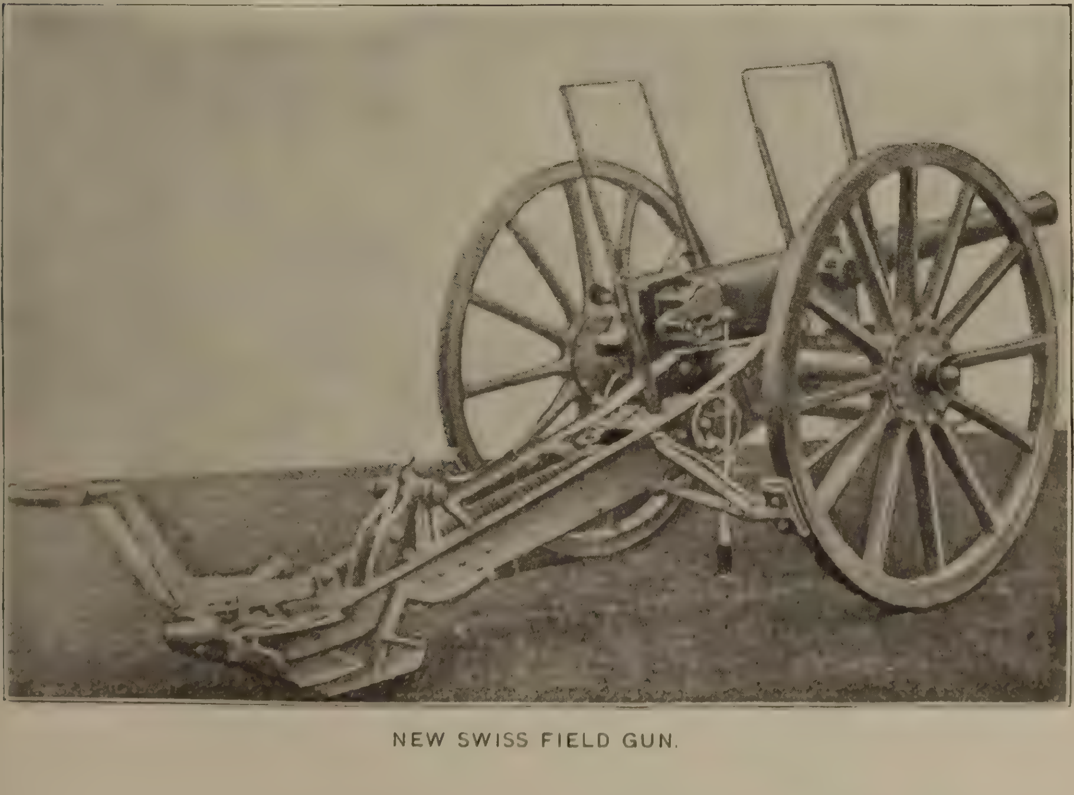
The wheels have a road brake, worked by a screw and a handwheel on the left of the piece at the hand of the gunner mounted on the footstep. The brake can also be used as a firing recoil brake, if for any reason the trail spade does not work.

The return-spring trail spade, folding back, turns around a axis carried by two supports fixed on the brackets. On marches on very uneven ground the trail spade is folded back upon the brackets. On firing, the entire piece recoils upon the spade, which holds firmly, compressing the springs of the shaft. Their extension operates the return to battery.

The gun's crew comprises a chief of piece and 5 gunners.

The No. 1 on the right works the breech, aims, and fires. No. 2 is





NEW SWISS FIELD GUN.

his assistant. The first number on the left is the loader. The other numbers set the fuse of the shrapnel and supply the piece.

Three men can serve the piece if necessary. The ammunition is shrapnel. High explosive shell can also be used, but is not yet supplied. The shrapnel is of steel, base fuse, with a base expansion ring. The brass cartridge case has a screw base primer and contains a charge of about 1 pound of smokeless powder. The cartridge case can be used a dozen times for recharging. The double-action fuse is graduated correspondingly to the sight up to 5,600 meters.

The limber of the piece and that of the caisson are identical; wheels of the same dimensions; the spokes and rims are of wood, the hub of iron.

The ammunition boxes open to the rear. The lid folds back from up-down, in the form of a table.

The boxes contain 40 rounds, packed by fours in a rattan basket, in two layers of two each. The cartridges are placed in a case of jute. The boxes have at the rear a frame to carry the men's kits. Three of the crew mount on the ammunition boxes. The step is provided with a foot rest. The boxes are of sheet iron. The ammunition carriage has a single ammunition box opening to the front, containing 56 rounds in two rows of seven baskets. The rear of the box has a table to receive the kits of the men. The ammunition carriage mounts three men, and has a brake. The battery has an ammunition cart of a new model.

The weight of the gun and breech mechanism is 700 pounds; of the piece in battery, 1,824 pounds; of the gun and limber, without crew, 3,384 pounds; of the loaded caisson, without crew, 3,368 pounds; it requires six horses. The extreme elevation is 18 degrees; extreme depression, 12 degrees; the weight of the cartridge, complete, is 17.3 pounds; the shrapnel, 14 pounds; number of balls in the shrapnel, 240, of 192 grains; the charge is a little over 1 pound. The rate of fire is from 9 to 10 shots per minute; the initial velocity, 1,640 feet per second, and the extreme range of fuse 6,100 yards.

The width of the carriage is 4½ feet, and the axle is 3 feet above ground.

AUSTRIA'S EXPERIMENTAL GUN.

Austria is experimenting, having supplied her artillery with three batteries of six pieces each of the 76.5-millimeter forged bronze guns, system Von Tiele; two or three batteries of the Skoda nickel-steel guns; also some 10.5-centimeter field howitzers; a rapid-fire mountain battery of 72-millimeters, and one battery of three or four pieces of Ehrhardt guns.

Howitzers seem to be forming a part of the field artillery of all nations; one-third of the arm is intended to be of howitzers. Russia led the way with a 6-in. field howitzer; France first introduced a 4.75-in., which has since been changed.

THE GERMAN FIELD GUN.

Germany has now come to a 3.03-in., 27-caliber, nickel-steel gun, weighing 7.7 hundredweight, 6 feet, 8 inches long, 32 grooves, in which the fermature requires two motions, and contains cocking, firing, and extracting mechanism. The tangent sight is a sight and clinometer combined, graduated up to 5,470 yards, but elevation up to 8,750 yards is obtained by quadrant. The gun can be traversed through an arc of 4 degrees each side, independently of the carriage. The rate of fire is a little over 8 rounds per minute. The muzzle velocity is 1,525 feet per second. The weight of the projectile is 15 pounds.

The brake is a wire-rope brake and a spur under the point of the trail. This gun mount has a decidedly big jump on firing.

The shell and cartridge are separate; the projectiles are shrapnel with 300 bullets, and a high explosive shell, both of steel; length, 3.8 calibers; weight, 15 pounds; provided in baskets.

The shrapnel has its bursting charge in the base; a double-action fuse is employed, marked up to 5,468 yards.

The weight of the gun and limber, packed, without men, is 33½ hundredweight.

The Germans also have a field howitzer, 98; carriage and limber of steel; caliber, 4.13-in.; between 11 and 12 calibers long; a one-motion fermature, with the usual cocking, firing, and extracting mechanism.

The ordinary tangent sight is used and a quadrant besides; no independent traverse.

The muzzle velocity is 984 foot-seconds. The brake is the same as that of the field gun.

The principal projectile is a high explosive shell of 35 pounds, a picric acid burster; there is also a shrapnel of 30 pounds, 500 balls, double-action fuse, marked up to 6,125 yards, which can be set for delayed action, when mine effect is desired.

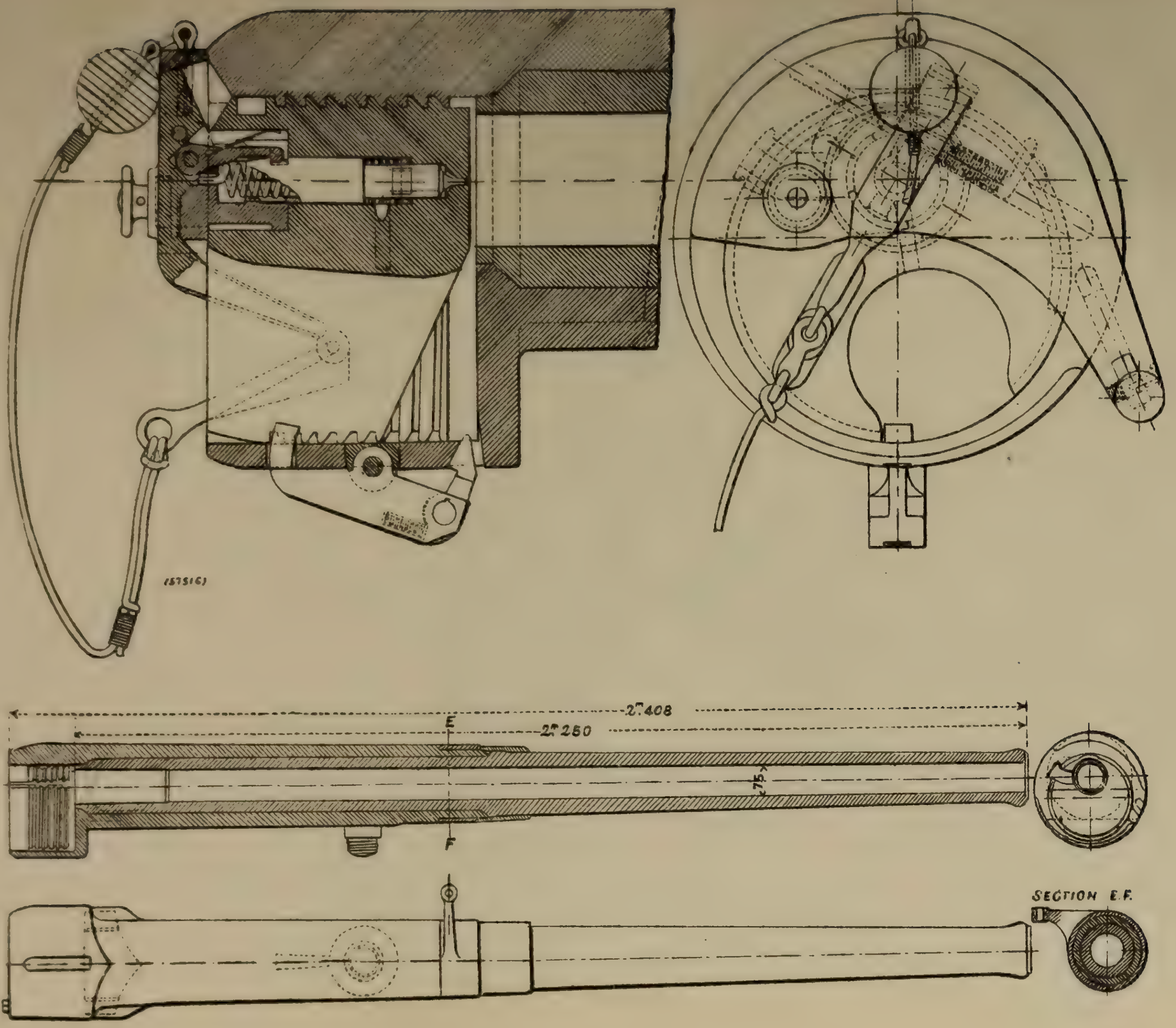
The weight of the howitzer and limber, packed, without men, is 39½ hundredweight.

THE BELGIAN FIELD GUN.

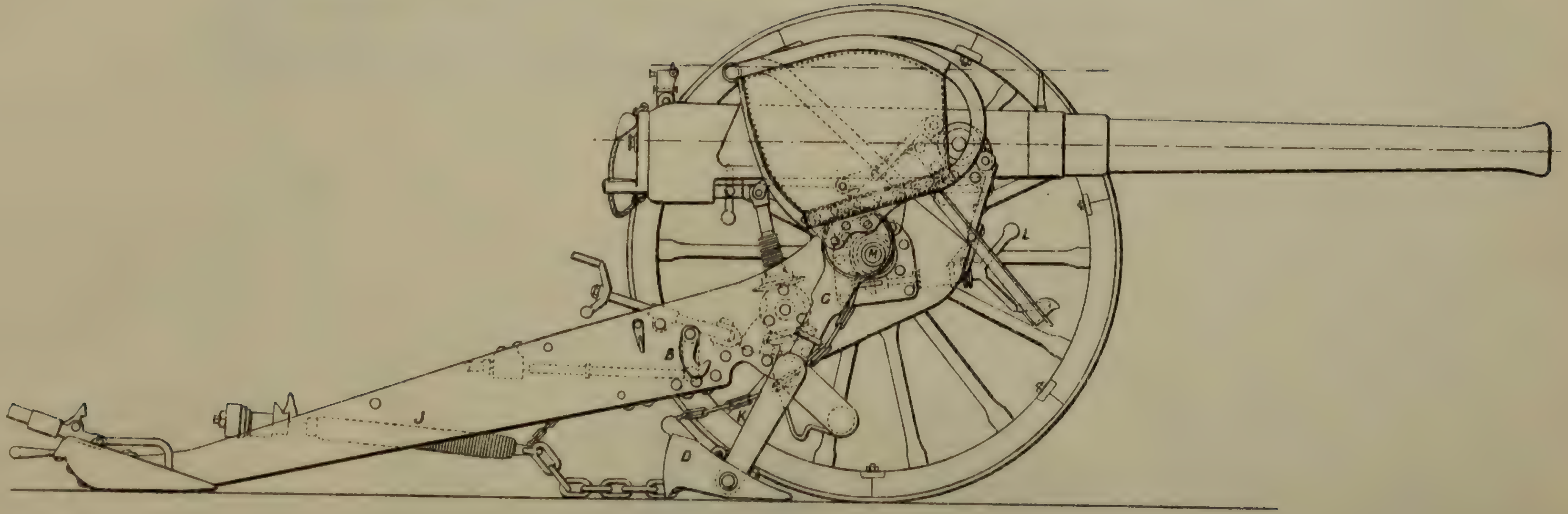
Belgium has adopted the Nordenfelt field gun: caliber, 75-millimeters (2.95-in.); 30 calibers long; 24 grooves, increasing twist; weight of projectiles, 14.33 pounds. The shrapnel, with cartridge case complete, weighs 18.1 pounds. The initial velocity is 1,722 foot-seconds.

The gun is composed of tube, jacket, and key ring. The breech mechanism is an eccentric screw lodged in the jacket. Attached to the jacket is a vertical pivot around which the gun can be given its horizontal train.

The carriage has two steel side frames, a hollow axle of nickel steel, and a cradle in which the gun rests. The cradle has horizontal trun-



THE NORDENFELDT FIELD GUN.



THE NORDENFELDT FIELD GUN.

nions resting in bearings on the side frames. At one end of each side frame is a shoe, joining the two frames. A handwheel under the gun gives vertical train, and a side wheel to the left of the breech gives horizontal train to 3 degrees each side. The vertical range is from 18 degrees elevation to 5 degrees depression. The wheel brake consists of two shoes, on which the wheels mount on firing. These shoes are joined to the axle of the carriage by eccentric arms and to one another by a steel tube; they have also spurs which grip into the ground.

The eccentric arms carry a column of Belleville springs, which renders them elastic, in order to compensate for irregularities in dimensions and to assist the shoes to grip the tires.

The chains are fixed to the trail end by means of a spiral spring, which limits the forward movement of the shoes and helps to pull forward the carriage when the recoil is ended.

The shoes are wedge-shaped, forming an inclined plane, down which the gun has a tendency to run back to the firing position. En route, the brake is lifted and attached to the trail by hooks on each side. It is claimed that this brake effectually checks the recoil of the gun and returns it to battery independent of the condition of the ground, and works on hard ground, where no spade nor spur can grip. No strain is apparent to the carriage.

The distance between the sights is one meter. The rear sight is curved in a circle, the center of which is the front sight, and it is supplied with a water level. This slides in a sleeve and is graduated in degrees and in thousandths of the distance between the sights. The water level can be turned through 12 degrees, six on each side of the horizontal; it gives the inclination of the ground and can be used for indirect laying of the gun vertically, if objects become invisible.

The limber consists of a frame of angles which carries a metallic case containing ammunition boxes. The body is of sheet steel, tightly closed, the inside being arranged to receive ten ammunition boxes, which are guided on the top and bottom by brass angles. The door opens at the top, drops, and forms a handling table. Each box contains four cartridges complete, and can be carried by one man.

An ammunition wagon and limber complete this outfit for horse artillery.

The weight of the carriage with complete equipment is 1,268 pounds, and with gun 2,028 pounds. The limber with ammunition complete weighs 1,739 pounds.

THE DARMANCIER-DALZON FIELD GUN.

This gun is made in two calibers, 70 and 75-millimeters (2.76 and 2.95-in.), and in heavy and light types for each caliber. The light 75-millimeter type weighs: the gun, about 700 pounds; the gun and carriage, about 2,000 pounds; the limber, loaded, 1,300 pounds, and the ammunition wagon, loaded, 3,400 pounds. The projectile weighs 14.3 pounds, and the initial velocity is 1,720 feet per second.

From 12 to 15 aimed rounds can be fired in a minute, and 20 unaimed.

The gun is composed of an inner tube, a jacket with trunnions, and a breech ring. The breech mechanism is on the Darmancier system, with interrupted screw threads. There are two types adapted for metallic and nonmetallic cartridges. For the former, the breech mechanism is operated in two movements for opening and closing; the latter type has a one-action mechanism.

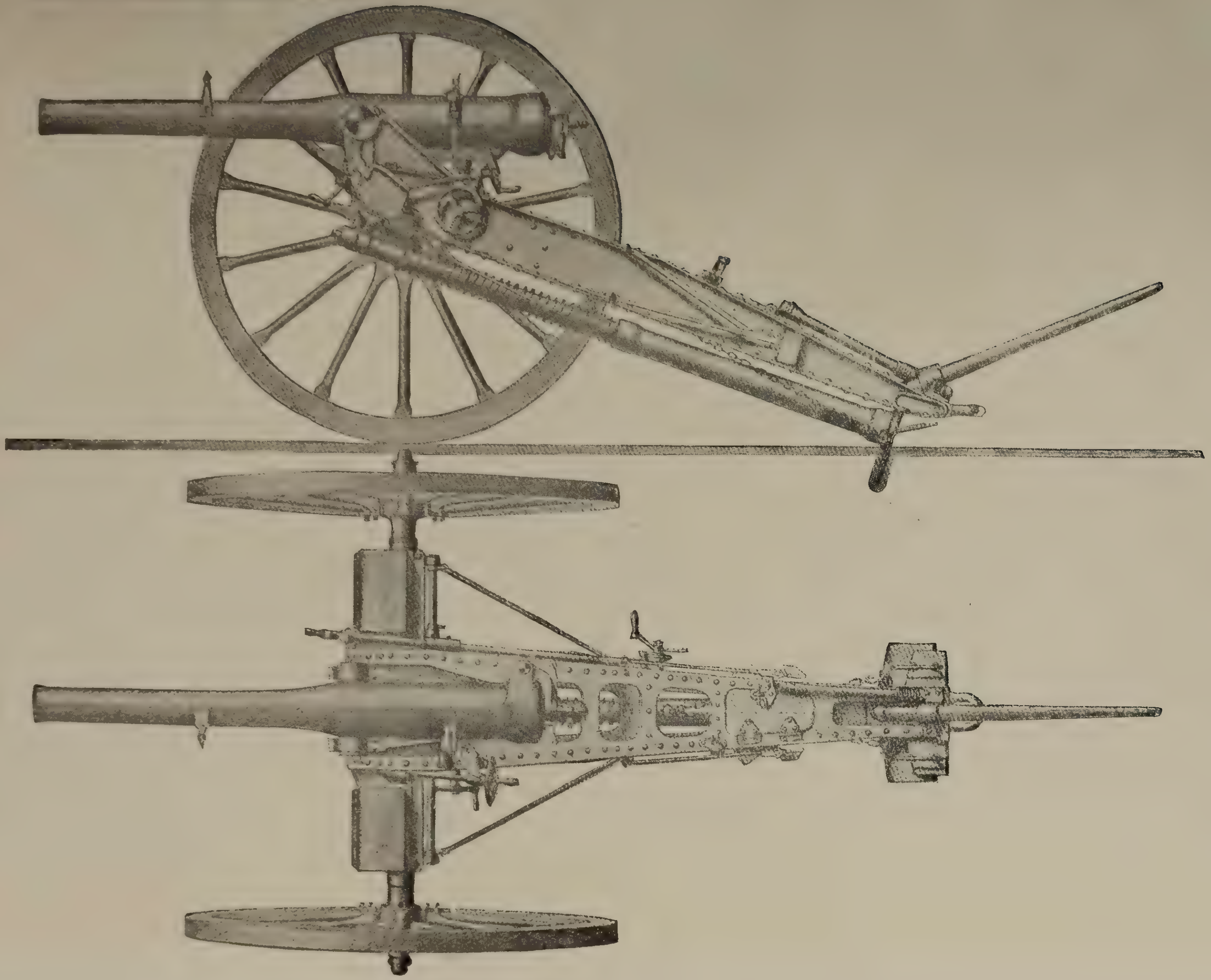
The parts include the hinged breechblock and levers, firing mechanism, and safety device to prevent premature fire.

In the two-movement mechanism the operating lever is on an axis parallel to that of the gun, and by turning it through 180 degrees from left to right the block is turned through 60 degrees, unlocking and liberating it.

The second movement turns the block around on its hinges. The striker is also set at safety and the cartridge case ejected. In closing, the operations are reversed. The main part of the gun carriage consists of a hollow steel-plate girder, a steel-plate trail, and an anchor. Powerful wheel brakes are provided to assist the immobility of the gun during fire. The cradle is of cast steel and is attached to the main frame by a vertical pivot at the back. This makes a secure connection and at the same time provides a convenient means of making the fine adjustments of the gun in lateral training. The movement is controlled by a crank and gearing. The gun can be trained through 4 degrees on each side of the axis of the mounting without displacing the trail. The range of vertical fire is from 20 degrees elevation to 6 degrees depression, the usual screw gear being employed.

The characteristic feature of this piece is the recoil arrangements. A long recoil, about 30 inches, is provided for to avoid sudden strain on the structure.

All parts of the mounting are free to recoil except the hydraulic buffer, which is placed between the outside plates of the trail, the front end of the buffer piston being fixed to the front end of the mounting, and to the rear end of the buffer is attached a strong spade. The trail is of special form and length, so as to slide back freely, all jump being thereby avoided. On firing, the spade is forced into the ground and arrests all movement rearward, but, the trail being free to move to the rear, the piston is forced into the buffer, at the same time compressing a powerful spring surrounding the cylinder. After recoil, when the spring reasserts itself, it runs the gun forward into firing position. This counter-recoil apparatus may be either a spring or an air chamber. If required the hydraulic buffer can be removed in about a minute. The mounting may then be used as an ordinary field carriage, the recoil being checked by means of the ordinary shoe brakes.



DARMANCIER-DALZON FIELD GUN.

brakes, seats for gunners, elevating and direction gear, lunette, trail handles, and places for attaching equipments. The axle is of tempered gun steel, and carries a ratchet for the pointing gear. The wheels have wood rims and spokes and ribbed bronze hubs. The pointing-direction gear is a handwheel on the left of the piece; the elevating wheel is on the right.

MACHINE-GUN SECTIONS.

Abroad mounted machine-gun sections are being attached to certain infantry battalions. This has been done in the German army, where, it is reported, they propose to increase the present proportion of this arm.

Heretofore the difficulty has been the noninterchangeability of the ammunition with that of the small arm, the ammunition of perhaps exactly identical caliber not being suitable for the machine gun, because of lack of structural strength, the machine-gun mechanism requiring heavier made cases.

It is now reported by the newspapers that this defect has been overcome abroad, where a manufactory has succeeded in making a cartridge case which fulfills the ballistic requirements of both arms and which does not tear when used in the machine gun.

SECTION IV.

TARGET PRACTICE.

The question of good shooting is now regarded as of paramount importance by every nation which possesses war ships. Naval battles are decided by the accuracy and rapidity of firing more than by anything else. The accounts of the battle of Santiago and of that of the Yalu show the terrible effect of modern ordnance when the deadly shell finds its mark. Fires are started wherever shells strike the woodwork, and men are driven from their batteries by the hail of projectiles from the guns of the secondary armament.

The leading navies of the world are paying great attention to the subject of target firing, and various plans and schemes are evolved to better the results and also to make conditions conform to those of actual combat on the sea; actual hits only count, and rapidity of fire figures largely in the result.

In the French navy long-range target practice has been the rule for some time. French officers long ago realized that battles in the future will not be fought merely at 2,000 yards—the favorite practice range—but at the very utmost limit.

Their idea, according to the technical papers, seems to be that it is doubtful whether ships in the future will ever get inside 2,000 yards, save by accident, that being the torpedo zone and also the zone at which armor is likely to fail; that at 6,000 or 8,000 yards the heavily armored ship will feel the advantage of her armor and the fast, lightly protected craft get most benefit out of her speed; and that it is at long range that the lucky shot will be made, and the lucky shot is not the product of chance so much as of skill. To acquire that skill practice is necessary.

The navy of Great Britain has held an elaborate series of prize target firings, and the results are said to show a steady improvement over those of previous years. Telescopic sights have recently been introduced in the British navy and have much improved the recent results. The entire fleet is now being rapidly provided with these sights.

Prize firing has been held by the ships of the Channel squadron, the Mediterranean squadron, and by the China squadron.

The following is the complete return of the firing for 1899, the full data having but recently been published in the *Rivista Marittima*, of Rome:

Return of prize firing for 1899.

Number of ships taking part.	Guns used.		Rounds fired.	Speed of ship.	Distance of target.	Time allowed.	Number of hits.	Per cent of hits.
	Caliber.	Number.						
	Inches.							
13 battleships[1] ...	13.5 16.25	48	252	8 knots .	1,400 to 2,000 yards.	2 periods of 6 minutes each.	84	33.3 (previous year 29.96).
9 battleships[2]	12	36	187	....do ...	.....do	....do	63	33
5 battleships[3]	10	40	185	....do ...	.....do	....do	63	34
14 cruisers[4]	9.2 8	35	288	....do ...	.....do	....do	100	34.7
40 cruisers	6 R. F.	307	2,347	....do ...	1,335 yards....	1 period of 6 minutes.	664	28

[1] *Nile*, 61 per cent, best score; *Sans Pareil*, 12.5 per cent, poorest score.

[2] *Victorious*, 52.3 per cent; *Cæsar*, 55 per cent, best score; *Magnificent*, 11.7 per cent, poorest score.

[3] The *Thunderer* with four 10-in. guns fired 47 rounds in 12 minutes and made 27 hits. The *Barfleur* with the same number of guns fired 24 rounds in 12 minutes and made 4 hits.

[4] *Royal Arthur*, 25 per cent; *Theseus*, 15.3 per cent; *Severn*, 14.3 per cent; *Magdala* (naval defense of India) with four 8-in. guns fired 38 rounds in 12 minutes and made 13 hits.

The results of the prize firing for 1900, channel squadron, have recently been published in the *United Service Gazette* of London.

Partial returns of prize firings, 1900.

LARGE GUNS.

Ship.	1900.		1899.	
	Shots.	Hits.	Shots.	Hits.
Majestic	28	[1]12	20	3
Prince George	23	7	18	7
Mars	25	6	25	5
Hannibal	18	5	27	6
Jupiter	16	4	21	8
Magnificent	19	2	17	2
Resolution	28	8	26	9
Repulse	24	8	26	10

6-INCH R. F. GUNS.

Majestic	108	52	97	28
Prince George	93	52	100	20
Mars	95	27	80	19
Hannibal	79	27	104	19
Jupiter	106	44	98	27
Magnificent	87	30	102	32
Resolution	76	31	79	22
Repulse	72	27	73	26

[1] This year's record is due to having one exceptionally good Gun Captain. One run of 6 minutes for each 12-in. gun; 2 runs of 6 minutes each for each 13.5-in. gun.

The 12-in. guns and the 13.5-in. guns made the same average number of hits per minute, 0.25. In all, 8 battleships with 6-in. R. F. guns fired 716 rounds, making 290 hits, against 193 hits in 733 rounds last year, the average rounds per gun per minute being 3.89, with 1.58 hits, against 3.98 and 1.05 in 1899. The newspaper reports of the firing by the *Terrible* on the China station give her percentage of hits as 60 with two 9.2-in. guns, with 9 hits in 15 rounds, each gun being allowed a six-minute run, and 76.8 per cent with the 6-in. R. F. guns, with 80 hits in 104 rounds, each gun having a two-minute run past the target.

The target used in the *Terrible's* firing was said to be a canvas one, 15 feet high by 30 feet long. The actual firing lasted twenty-six minutes; the speed was 12 knots. The 9.2-in. guns fired 15 rounds during their six-minute runs, or 7.5 rounds per gun. Out of the 6-in. guns, four made a 100 per cent of hits, eight guns averaging 90 per cent of hits.

Some interesting long-range firing has been inaugurated in the Channel Squadron, beginning with the flagship *Majestic*, off Berehaven, and has been reported as follows in the English press:

The *Furious* early in the morning towed the target out; this target was the usual canvas one, but was 100 feet long and 25 feet high.

The battle squadron and the cruiser *Diadem* stood out to sea. A few miles out the target was moored so as to lie broadside on to the *Majestic*, which stopped her engines when about 9,000 yards off.

The first division arranged themselves to the westward on a line of bearing at right angles to the line of fire of the *Majestic* on commencing at a distance of 2 miles from the target, the second division in the same order to the eastward.

The firing was carried out as follows, with 12-in. and 6-in. guns, at 15 knots speed:

1. Preliminary shot at 6,000 yards, ship stationary.
2. Attacked target for four minutes, steaming toward it, opening fire at 6,000 yards with the target bearing 45 degrees before the beam, firing in all 4 rounds from her turret guns and 25 rounds from her 6-in. guns (her main deck 6-in. guns did not bear until the last minute and a half of the firing).
3. Attacked target right ahead, opening fire at 6,000 yards with foremost turret and 2 foremost upper deck 6-in. guns for three minutes only, firing in all four 12-in. and twelve 6-in.

The remainder of the squadron, which was lying with engines stopped, had 7 registering officers, each officer only recording the rounds within the special limit detailed to him for the number of yards short or over.

Each officer had to send in a return to the admiral, together with the remarks of his captain on the results of the firing.

During the second trial the canvas target partly tumbled down, having been pierced four times by 6-in. shot and once by 12-in.

The other vessels of the squadron, beginning with the *Mars*, were to follow the above routine.

All trials were finished by noon, when towing targets were put over and firing carried out with 6-in. guns, expending part of the quarter's allowance of ammunition, at 2,000 yards at a speed of 10 knots, the ships anchoring in the harbor just before dark.

This firing is to be held by all ships of over 4,000 tons displacement once a year under the following conditions: A target 50 feet long by 25 feet high, and having a mast 35 feet high, is to be laid out, and at this each ship is to make two runs on a straight course, opening fire at 6,000 yards from the target, one run being for each broadside. The ship is to steam at 12 knots, and firing is to be continued for four minutes during each run.

All heavy guns are to fire on each run, but not the light rapid-fire guns nor machine guns.

The firing basis is not to be marked by buoys, and the distances of the target are to be found and given to the guns by the methods which would be available in actual war. One ship is to mark for the other, and only actual hits are to be counted.

The vessels of the British Mediterranean fleet held a somewhat similar target practice off Aranci Bay. Two targets were made use of, each containing about 450 square feet, 30 feet long by 15 feet high, painted red, and two runs at 10 knots were made by each ship, one at each target.

The success of each ship was tested by the number of shots that might be considered to have hit an imaginary *Cæsar*.

At the shorter of the two ranges at which practice was carried on—between 4,200 and 5,500 yards—the following order of merit was established:

	Percentage of hits.
Illustrious	46
Cæsar	37
Victorious	28
Renown	25
Royal Sovereign	25
Royal Oak	23
Andromeda	22
Ramillies	19

In the firing at longer ranges, of from 5,000 to 7,400 yards, carried on later off Valona, a somewhat more complicated system of estimating results was introduced. For a shot considered to have struck the hull of the imaginary *Cæsar*, 12 points were allowed; for the superstructure, 3 points; for the funnels or masts, 1 point only. Upon this plan the above order of merit comes out as follows:

	Average points per shot.
Renown	2.6
Canopus	2.5
Ocean	2.4
Royal Sovereign	1.7
Illustrious	1.5
Ramillies	1.2
Cæsar	.9
Royal Oak	.5

In this competition the first ship, the *Renown*, out of 30 shots, succeeded in hitting the imaginary hull 6 times, while the *Royal Oak*, out of 34 shots, hit it only once.

GUNNERY SCHOOLS.

In furtherance of the system of training gunners for the fleet, the British Admiralty is making considerable developments at the central school of gunnery, Whale Island. Along the front of the battery, where men are practiced with every naval gun from the 9.2-in. downward, a switch-back railway is under construction some 50 yards from the muzzles of the guns. Along this railway it is proposed to run a fleet of model ships at varying speeds and of different dimensions, from a yard to a foot in length, each ship being a solid piece of iron. Guns will be fitted with Morris tubes and the men in the battery will be required to so sight their guns as to bring them at the shortest notice on the moving target. In this way men, before passing out of the school, will be trained in straight shooting and rapid sighting, the essential qualities of good gunnery. Provision has also been made for an extension of the battery, which is already the largest in the Kingdom, owing to the annual increase in the number of officers and men who go through the course. The idea of moving the ships on the switch-back principle is an excellent one, as the targets will represent an enemy's ships in a sea way, and the practice thus obtained can not fail to have its influence on the annual prize firing in the fleet.

TOWING TARGETS.

Towing targets used by the British Channel Squadron consist of three parallel spars about 30 feet long, about 4 or 5 feet apart, the center one somewhat the larger, supporting a rectangular framework, filled in with iron wire painted red. The spars are towed by a wire hawser. It was found necessary to attach two other spars to the hawser at intervals of about 50 feet to prevent the target from towing under when turning. These targets can be towed at a speed of 10 knots, and will neither tow under nor capsize in a short turn at that speed. They are towed from 200 to 600 feet astern of the towing vessel.

GUNNERY SHIPS.

In connection with the courses at the gunnery schools at Portsmouth, Sheerness, and Devonport, the British Admiralty have instituted a new plan by which small-gun practice at sea will be more efficiently carried out. Hitherto gunboats have been provided for each school, and in these somewhat diminutive vessels small numbers of men have gone to sea day by day for target practice, firing at a latticework target towed by tugs at various speeds and distances.

In the future, first-class cruisers of the *Orlando* type are to be provided to serve as seagoing gunnery tenders. These will proceed to sea for a week's cruise with the training classes for gunnery instruction.

The cruisers selected for this purpose are the *Narcissus*, *Immortalité*, and *Undaunted*, stationed respectively at Portsmouth, Sheerness, and Devonport. The battleships attached to the gunnery schools will continue to carry out the heavy-gun and target practices.

FRENCH TARGET PRACTICE.

The French have inaugurated an elaborate system of training for their fleet in target practice.

Instruction on board vessels consists in firing with reduced charges, in range-finding practice and in target practice. The object is to select the two classes of gunners and their assistants and, when selected, to give them practice and to determine if they maintain and improve their standard.

Each class of gun—that is, main and secondary battery guns—has chief gunners and assistant gunners, who alone are allowed to fire their particular piece.

Instruction consists in gun pointing and firing with light guns by means of a simple device which permits firing a cartridge from a dummy cartridge tube or from a gun barrel fitted to an empty cartridge case. This firing is made at small balloons placed awash at distances of 50 or 60 feet. Then follows regular monthly subcaliber practice at sea. Each quarter they hold two day and one night firings at anchor at fixed targets, and firings by day and by night at sea at fixed or moving objects with the ship cleared for action. For the fixed targets two groups of balloon targets are moored on each side of the vessel on lines oblique to the planes of fire, on one side at a mean distance of 1,100 yards for subcaliber tubes of 2.55 inches and over, and on the other side at a mean distance of 550 yards for dummy cartridge tubes or subcaliber tubes of 1.45 to 1.85 inches. Distances are estimated by the gunners, then trial shots are made. The gunners are required to fire alternately at each target. Each gunner is marked for accuracy and rapidity of fire.

For the night practice at anchor at fixed or moving targets vessels are anchored by squadron or division in single column, using kedges if necessary. Two balloon targets are anchored on each side, slightly different in direction and distance, the first two at about 875 yards for subcaliber tubes of large and medium caliber guns and the 2.25 inch tubes, and the two others at about 440 yards for the dummy cartridge tubes and the 1.45 and 1.85 inch subcaliber tubes.

For the practice at sea, with ship cleared for action, day and night practices are held against fixed or moving targets, at maximum distances of 1,640 yards for subcaliber pieces of 2.55 inches or over, and at 656 yards for dummy cartridge firing tubes and subcaliber tubes of 1.45 and 1.85 inches. For the practice by day, with ship cleared for action and with fixed targets, vessels act singly and together, steaming first singly between balloon targets anchored at intervals at ranges of 1,969 to 750 yards, and then steaming together between lines of balloon targets at varying distances.

The practice by day or night at sea, with the ship cleared for action, at moving targets, is executed as follows: Vessels are formed in regular order, the firing being executed against two Marengo targets towed by torpedo boats or other light craft, at 6 knots, and 440 yards astern. At night searchlights are used to illuminate the targets and to sight vessels which may cross the line of fire. The train of guns is limited to 45 degrees each side of the line of fire for the safety of the towing vessel.

Once a year record practice is held. Its main object is to select for each piece for the ensuing year the gun captains and their substitutes, these being chosen, as far as practicable, from among men having one more year to serve. This practice is held at anchor, in fair weather, at a distance of 2,400 yards at a moored floating target.

If for any reason this practice should be held at sea, moderate weather must be selected, and the firing vessel describes around the target the circumference of a circle of a radius of 2,400 yards, keeping the target abeam to avoid much training of the battery.

In this case pyramid targets are employed. Record practice with light guns follows that with heavy guns, at balloon targets placed at distances of from 1,640 to 1,100 yards for the different calibers.

Badges and money prizes are distributed according to excellence and to the size of the gun.

Three times a year practice is held under the different aspects that may develop in battle, two of these with exercise charges and projectiles filled with sand and one with service charges and projectiles.

Other evolutions comprise combats between single vessels, combat by divisions, and combat by squadron, attacks on coast batteries, and bombardments; also guarding against attacks by torpedo boats.

Dark objects presenting somewhat the dimensions of a vessel, old hulks, islets, silhouette targets, large and small, are used as targets under conditions simulating as near as possible the conditions of actual combat. Practice with shrapnel at silhouette targets suitably placed to represent the enemy and practice from boats and on shore with the landing gun is held.

When practice can not be had against an old hulk or an islet, targets made at a navy-yard or on board are used.

SMALL-ARM TARGET PRACTICE.

This subject has received a great impetus by reason of the Boer war. In Great Britain the question of ranges where the high-powered modern small arm may be used with safety is being agitated. Many of the small ranges of the volunteers have had to be closed, and the authorities are using great efforts to obtain and lay out great range parks amply suitable to present weapons.

Small-arm practice is very closely followed up in many European countries, notably Germany, Switzerland, etc., while in others it is but spasmodic; a foreign war or the passing scare of hostilities revives the attention, and, while there are in all countries crack shots who keep up their skill from liking for it, the mass of the male population lose interest in the subject, often perforce.

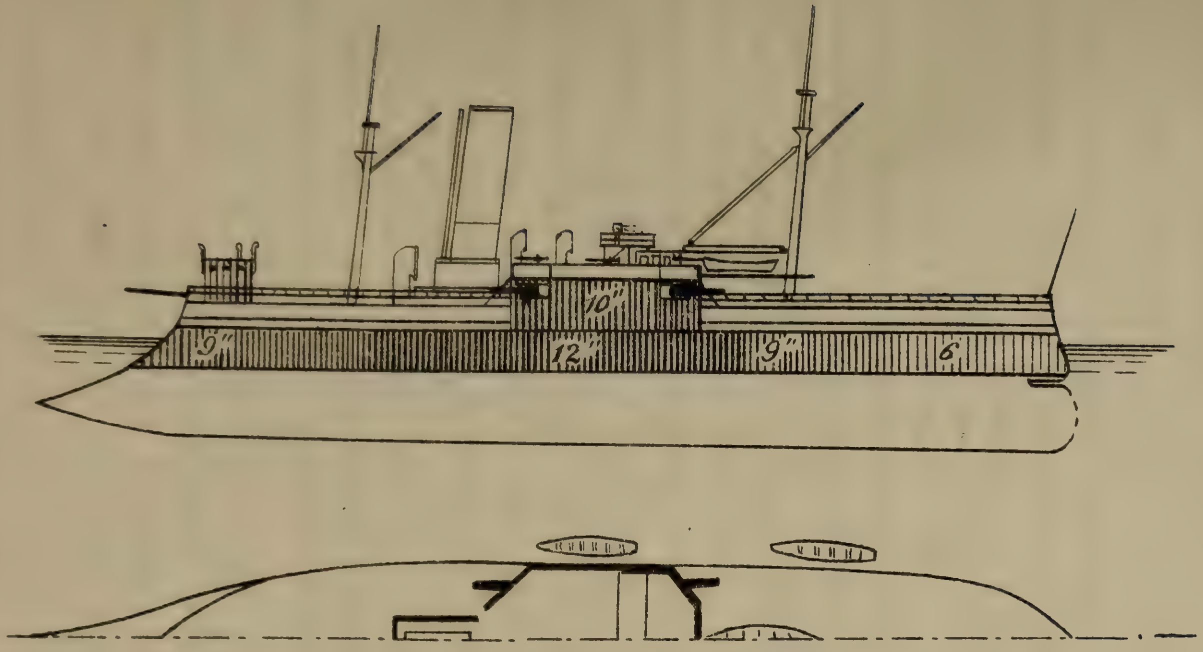
It will, in this connection, be interesting to watch the results of the international shooting tournament to be held under the auspices of the National Rifle Association at Sea Girt, N. J., August 30 to September 7 of this year. An Irish team, a Canadian team, and a Swiss team (which last year won the world's championship at the Paris Exposition) have arranged to compete. There will be an American team of civilians, and teams have been promised from the Army, Navy, Marine Corps, and the National Guard of different States.

THE BELLEISLE EXPERIMENTS IN THE BRITISH NAVY.

From the various newspaper accounts, especially those of the London *Engineer*, mostly incomplete, the following information has been extracted, and the results of the experiments, when taken into account with the results of Santiago and the Yalu, are very interesting as showing the effect of modern gun fire on armored and unarmored ships.

Beginning with the target, the published details give her characteristics as follows:

Displacement	tons	4,870	Armor, wrought iron:		
Hull		Iron.	Belt	inches	12–6
Length	feet	245	Redoubt	do	10
Beam	do	52	Bulkheads to redoubt	do	9½
Draught (mean)	do	21	Conning tower	do	9
Armament:			Flat deck	do	2
12-in., 25-ton, M. L		4	Deck to redoubt (flat)	do	3
6-pounder R. F		6	I. H. P		2,600
Machine guns		6	Trial speed	knots	11.5
Torpedo tubes (above water)		2			



Sketch Plan and Profile of the Belleisle.

The boilers are rectangular box; engines, horizontal, common return connecting rod. She has two 4-bladed screws.

This vessel has an enormous ram, thin, narrow, protruding a great distance, deep below the water line. She was supposed to be unseaworthy from instability. This vessel was built at Samuda's yard, Poplar, in 1876, for the Turkish Government, and was to be named the *Payki-Sherreef*, but was stopped when ready to leave by the British Government as contraband, owing to the Turko-Russian war. She was purchased by England for £240,000.

The object of these experiments was said to be primarily to test the effect of modern shell fire on personnel and material. She was to carry coal, boats, and stores, dummies representing the personnel at the different stations. Wet sand as a protection to the decks against fire was to be tried. She was to be moored on a shoal with 2 feet of water under her and to be fired at for nine minutes by a battleship.

The *Majestic* was selected for this duty. She is a first-class battleship of 15,000 tons displacement, carrying four 12-in. B. L. R., twelve 6-in. R. F., sixteen 3-in. R. F., and twelve 3-pounder guns.

The *Belleisle* left Portsmouth under her own steam at a speed of 7½ knots, and was moored on the Medmery Bank off Selsey Bill, 10 miles east of the Isle of Wight, and 2 miles from shore. Between this bank and the shore at right angles to the firing line to seaward, there is a 7 fathom channel through which the *Majestic* steamed, the route being buoyed. A fleet of 24 torpedo-boat destroyers kept fishing and other vessels outside the danger zone. The *Majestic*, steaming at 6 knots in an arc varying from 1,700 to 1,300 yards range, fired in all 8 rounds of 12-in. common shell; 7 rounds of 12-in. armor-piercing shell, about 100 rounds of 6-in. lyddite at the bow and battery; about 100 6-in. common shell at the stern; 400 3-in. shell; 750 3-pounder, and many Maxim shells. Full charges were used throughout by all guns. Approximately 30 to 40 per cent of the projectiles were effective, about 10 per cent were clear misses.

On the belt below the funnel are two marks where shells have burst, apparently 12-in., the after one showing a 12-in. depression of 2 inches. The armor belt just below is cracked laterally for some 7 feet and a vertical seam opened. The lateral crack is almost 6 inches wide. There are marks of a 6-in. shell in the aperture. On the water line, directly under the battery, there is a large hole made by a 12-in. shot; this was the second 12-in. fired. This is the probable cause of the crack farther forward, as this hit blew the side right in, sending one fragment of the armor right up through the flat-armored deck above it. The belt here is from 9 to 12 inches thick. Right abaft the casemate a 12-in. shell struck, blowing away some 100 square feet of side, which looks something like the ruins of a recessed port.

In the armored bulkhead there is a penetration, made either by the above-mentioned 12-in. shell or by a 6-in. shell that did not burst. Well aft another 12-in. shell struck, blowing in a large piece of the side; the deck above has disappeared, and the iron deck beams are curled up into a shapeless mass, much like shavings. The extreme area of damage is about 10 feet; internally the whole of the cabins in the vicinity were reduced to match wood. At the after end of the unarmored top of the battery and toward the after end of the funnel base there are huge holes, averaging perhaps 5 to 7 feet each. Most of the edges are bent upward. High up on the port side after porthole is a clean, nearly exactly circular penetration, of exactly 10 inches in diameter; around it is an irregular depression, with a maximum depth of 2½ inches and about 2 feet across at the widest. The head of a 12-in., a 6-in. lyddite, and a fragment from the hole in the side below have all entered into the conjectures of those who have seen the hole.

On the upper and outer edge of the after port, starboard side of the battery, another unidentified projectile chipped out a piece of armor and burst. This comprises all the marks from large projectiles. The bow and battery were fired at by 6-in. lyddite projectiles; the 6-in. common shell were directed aft. Between the damage done by the one and the other there is no comparison. Both have made holes in the unarmored ends; both have done no harm at all to the armor; both have made match wood of the woodwork inside. But while the 6-in. common has broken things, lyddite has pulverized the same. Practically there are no remains beyond a dust. The deck in places is gone. The edges of boards have the appearance of dry rot. The ends look as if they had been struck by a hammer. There is no sign of charring. Where common shell has burst between decks, the deck above shows no sign of it, but where lyddite has so burst huge holes are blown through, the deck about being bulged up.

The water line is studded with marks of impact of small shell which have made no impression. Abreast of the funnel, where armor is thickest, there are several dents of an inch or two. Many shells have burst against the battery. The masts are in a bad way, the foremast the least damaged; both signal yards were shot away; both peaks were dropped. The only boat left is the steam pinnace, carried between the battery and the mainmast. A 6-in. common shell blew the starboard side of this into streamers. Where the ship's funnel was, there is but a gaping hole with strips of iron twisted over it. The ship's bridge is much bent and twisted; the search light blown away. The conning tower was not touched. The upper works were blown to pieces, the 6-pounder either knocked clean away or else blown sideways with some of its fittings melted. Ventilators were pitted with innumerable small holes from splinters and fragments. The main steam pipe was cut.

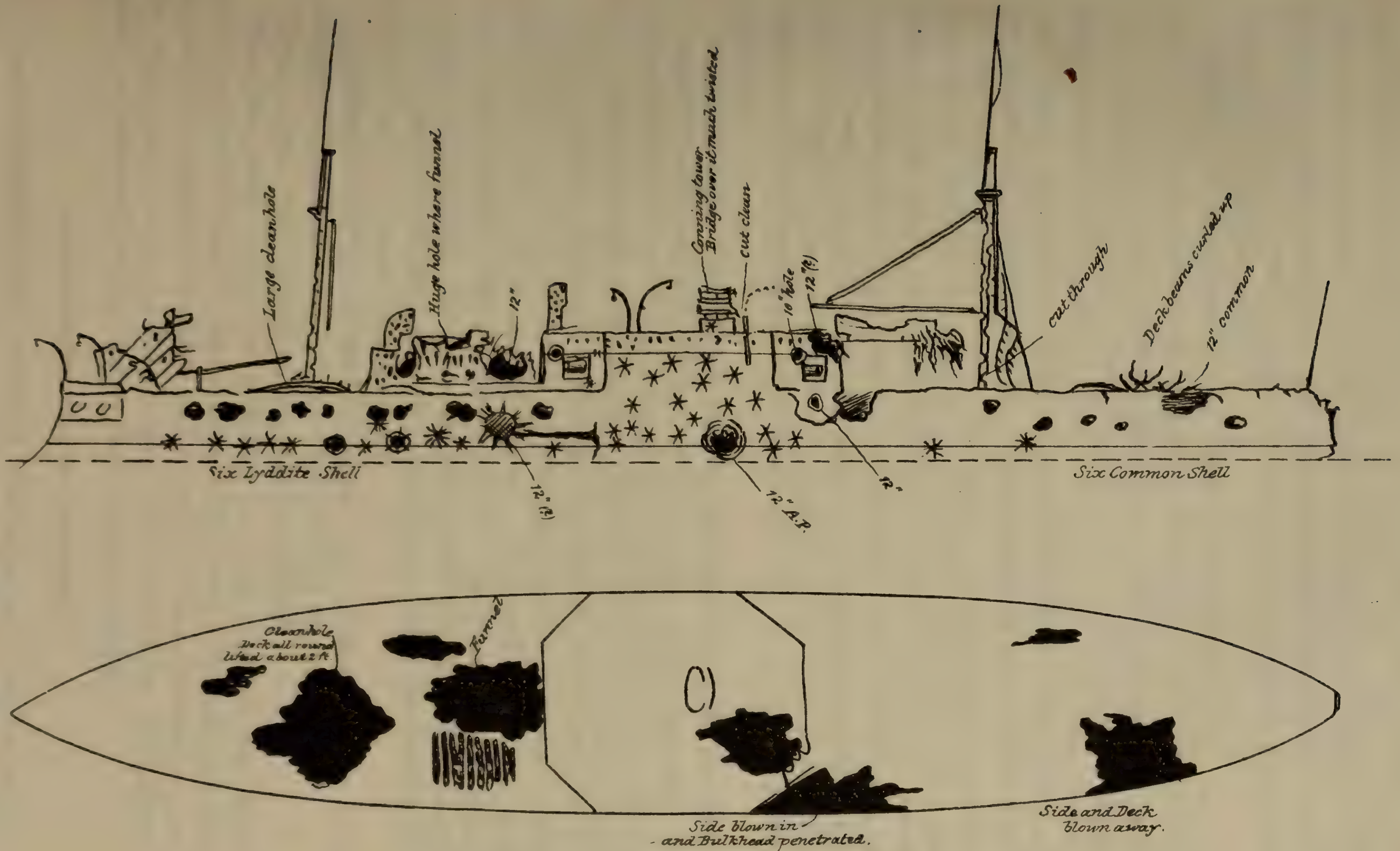


Diagram – Showing Effect of Fire.- Belleisle.

Inside the battery, in which at least 1 shell that had entered a porthole had burst, all the gun sights were destroyed. The guns themselves were absolutely unhurt, but were temporarily useless from damages to sights and gear. The dummies around them were burned. Two davits were cut entirely in two. A few small projectiles embedded themselves in places.

Directly the firing had ceased officers boarded the ship; she was found full of dense smoke; dummies were burning; practically nothing was to be seen because of smoke and fume. Being supposed to be on fire, water was pumped in, bringing her down sufficiently so that the water rushed in by the 12-in. shell hole about the water line, and the vessel sank. Some of the *Belleisle's* hose was still working, but much was cut and the valves destroyed. Two torpedoes were in the tubes; one was found intact, the other was gone. One-half the 6-pounder guns of the *Belleisle* were in firing condition after the action had finished. The supposed particular object of this experiment was to determine the effect of gun fire on woodwork. The conclusion seems to have been reached that useless anxiety has been displayed on this point, though it seems to have been lost sight of by some that lyddite fumes are not supporters of combustion, nor is it an incendiary explosive.

The lesson of the *Belleisle* shows that the efficiency of the personnel in rapidity, with accuracy of fire, is of the first importance and will be the principal factor in the result; that naval battles of the future will be short engagements; that the first accurate shot will greatly influence results. More protection for the ends of vessels and for the personnel at the guns, in fact a greater distribution of armor, seems needed; the belt must be carried higher. The terrible concussion of lyddite and kindred high explosives seems clearly shown. It seems essential to have armor carried to the stem and stern, and high enough so that water can not enter in such quantity as to alter the trim and so handicap the movements of the vessel.

The batteries must be protected against the bursting inside their casemates of shell carrying lyddite or other high explosives.

Large, open, unprotected ports are to be avoided.

Since the above trials the *Belleisle* has been repaired and made ready for further trials in the autumn of this year. The latest modern armor is to be applied, the bow and stern are to have protection, and live torpedoes are to be loaded into her above-water discharging tubes; an armored deck and turtle back are to be added.

TRIALS WITH THE SCORPION AT BERMUDA.

It was reported this spring that the old iron-clad *Scorpion* at Bermuda would be used as a target to further determine the effect of modern gun fire.

This vessel has been lying as a noneffective ship at Bermuda. She is one of the earliest ironclads, she and her sister ship, the *Wivern*, now at Hongkong, having been built by Messrs. Laird, of Birkenhead, in 1865, and were believed to have been intended for the Confederate service. Their completion at that time was prevented by the British Government. The two vessels then had their names changed to *El Tousson* and *El Monassar*, indicating that they were intended for the Turkish Government. Eventually they were purchased by the British Government. The *Scorpion* has a complete belt of 4.5 inch wrought iron, and her two turrets are similarly protected. The ship herself is built of iron; she cost £111,614. She carries four 9-in. muzzle-loading guns and has a speed of 8½ knots.

She was prepared for steaming, and wooden dummies were rigged up at the crews' stations. The experiments began on May 14, 1901, off St. Catherines Point, St. Georges, where she was anchored, the flagship *Crescent* firing at her first from the 3 and 6-pounder rapid-fire guns at 1,000 to 2,000 yards, and then with the 6-in. at 6,000 yards. It is reported that the secondary battery guns destroyed the dummy figures about the decks and everything else destructible, and that it would have been impossible for any crew to have survived such a fire. The firing from the larger guns, although the shells were very accurately placed, was not so good. Out of some 20 shells, which fell within a small radius, only two or three hit the mark. These, however, were very destructive, and it is understood that the effect of the lyddite shells was considered satisfactory, one shell which burst inside the *Scorpion* practically wrecking everything on board.

The experiments were continued on the following days. A charge of gun cotton was used, in order to ascertain the effect of an exploded torpedo under the poop. A great deal of wreckage was caused by the explosion, but not sufficient to prevent several officers remaining on board during the explosion. Firing was then continued with the 6-in. and other guns, some excellent practice being made and much damage done—several clear holes showing through the *Scorpion's* turrets, funnel casing, and ends. Her machinery stood the shaking very well, and to the last remained effective. The masts, hull, and funnel sustained much damage, and the ship was finally run ashore, where she sunk on the rocks, the deck being still above water.

SECTION V.

ARMOR.

The struggle for supremacy between guns and armor still continues, a struggle in which there have been many remarkable vicissitudes, the triumph of the one being quickly followed by such improvements in the other as to once more disturb the balance of advantage and urging modern ingenuity to renewed efforts. The histories of the gun and of the armor plate may be said to be inseparably connected. At present the armor plate holds the advantage, but the recent increase of initial velocity of the modern gun shows that armor makers must continue the race to retain their slight advantage.

The 6 inch armor plate is the ordinary protection of the broadside guns. This thickness of Krupp armor will now keep out a 6-in. Holtzer armor-piercing projectile.

At a recent test of Krupp armor made by the Carnegie Works for Russia, three 6-in. Holtzer armor-piercing projectiles, fired at 1,910–1,930 foot-seconds, did not crack the plate and penetrated but 2 inches.

A sample plate of a group made by the Bethlehem Company for Russia was recently tried. The plate was a 5 inch Krupp, and was struck by one 5-in. Midvale and two Carpenter projectiles at velocities of 2,143, 2,099, and 2,072 foot-seconds. The first two shots penetrated 3 inches; the third 2 inches. There were no cracks in the plate.

In England a 4 inch armor plate, manufactured by Armstrong, Whitworth & Co., was fired at by a 4.7-in. R. F. gun, 45-pound projectile, 1,635 foot-seconds striking velocity. The penetration was 1 inch; no cracks nor bulging. The projectiles were shattered.

In all, three similar plates were tested with identical results.

The following tests of armor have been published in the *Engineer* of London and furnish an idea of the present state of armor of its class:

TESTS OF A CAMMELL 4 INCH K. N. C. PLATE.

The 4 inch Krupp non-cemented plate is used for shields of guns and also on the Continent for inland defenses. It is a sample of tough steel, the face being made as hard as possible without cementation. These plates are generally passed on resisting the attacks of Palliser projectiles only, but of a large caliber compared with the plate's thickness. Here the plate, which is 4 inches thick and 5 feet square, was first attacked on the *Nettle* on February 2, 1900, by three rounds from a 5-in. B. L. R., fired as below:

No. of round.	Charge.	Projectile, nature.	Projectile, weight.	Striking velocity.	Striking energy.	Calculated perforation through iron.	Fig. of merit, or relation of calculated perforation to thickness of plate.
	Pounds.		*Pounds.*	*Foot-seconds.*	*Foot-tons.*	*Inches.*	
1	10 S. P	Palliser	50	1,406	685	6.33	1.58
2 3	15½ S. P	do	50	1,750	1,061	8.79	2.20

Fig. 1 shows the plate after this attack, which has been completely resisted. We need not say that the Palliser projectiles break without delivering the full energy indicated in the table above at the point of impact. The severity is increased by the fact that the caliber of the projectile and total energy is unusually large compared with the plate. It was, however, in this instance decided to try how the plate would bear a further test with the 4.7-in. gun firing steel armor-piercing projectiles, as shown in the table below, the firing being carried out on Whale Island on March 23, 1900.

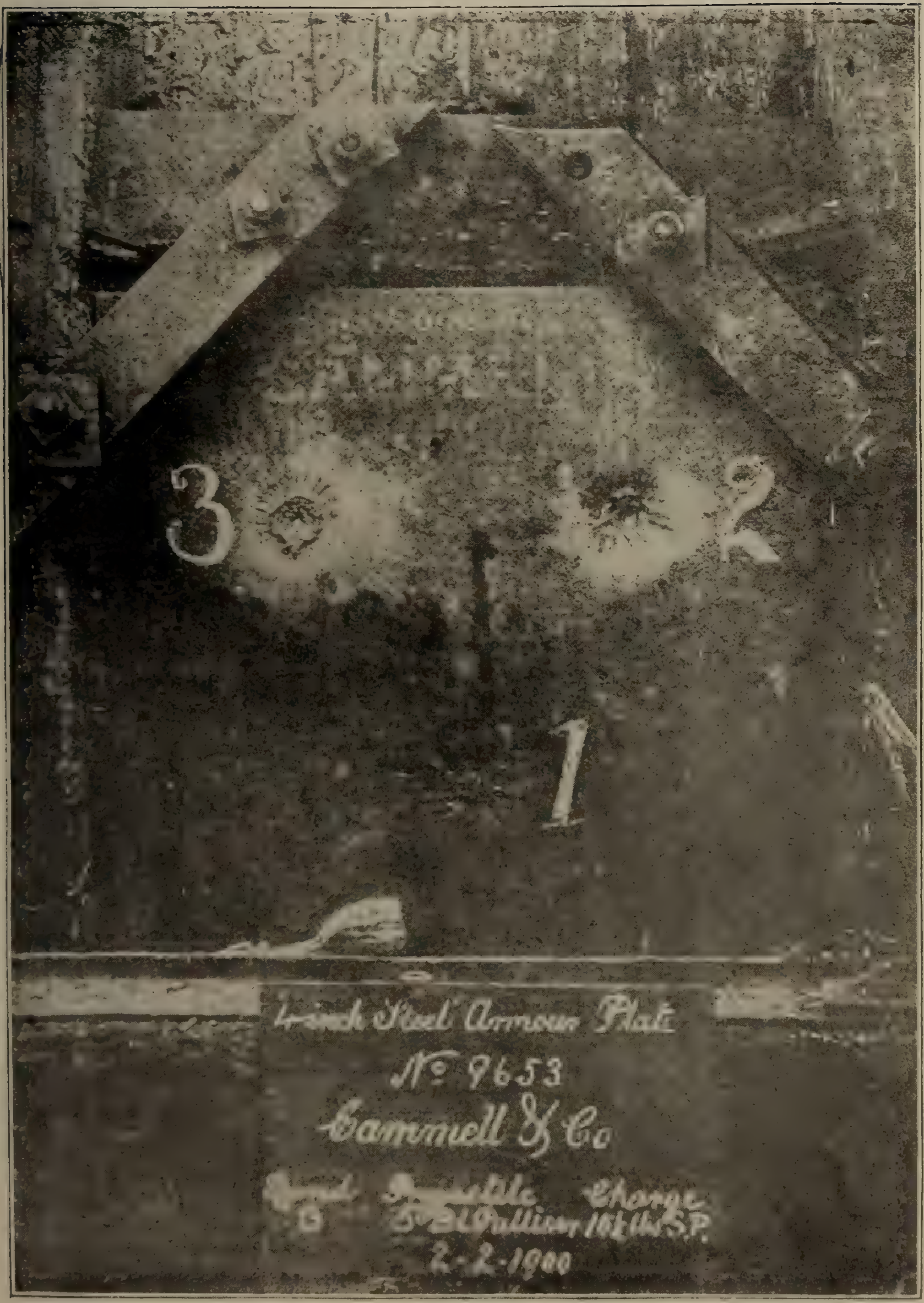
No. of round.	Charge.	Projectile, nature.	Projectile, weight.	Striking velocity.	Striking energy.	Calculated perforation through iron.	Fig. of merit, or relation of calculated perforation to thickness of plate.
			Pounds.	*Ft. sec.*	*Ft. tons.*	*Inches.*	
(1)	Cordite, 2 lbs. 11½ oz.	A. P. shell plugged.	45	1,720	923	8.38	2.10
(2)				1,753	959	8.64	2.16
(3)				1,756	962	8.65	2.16
(4)				1,813	1,026	8.09	2.27

Figs. 2 and 3 show the front and back of the plate after this second trial. In Fig. 3 the four rounds just fired only are numbered, but the points of impact of the former test are distinctly visible, and may be easily found by comparing 1 and 2 together, when the 1 of the first series will be seen a little below No. 4, and rather to the right; No. 2 to the right and below the chalk figure 1; and No. 3, which has scaled off to the left and below No. 1.

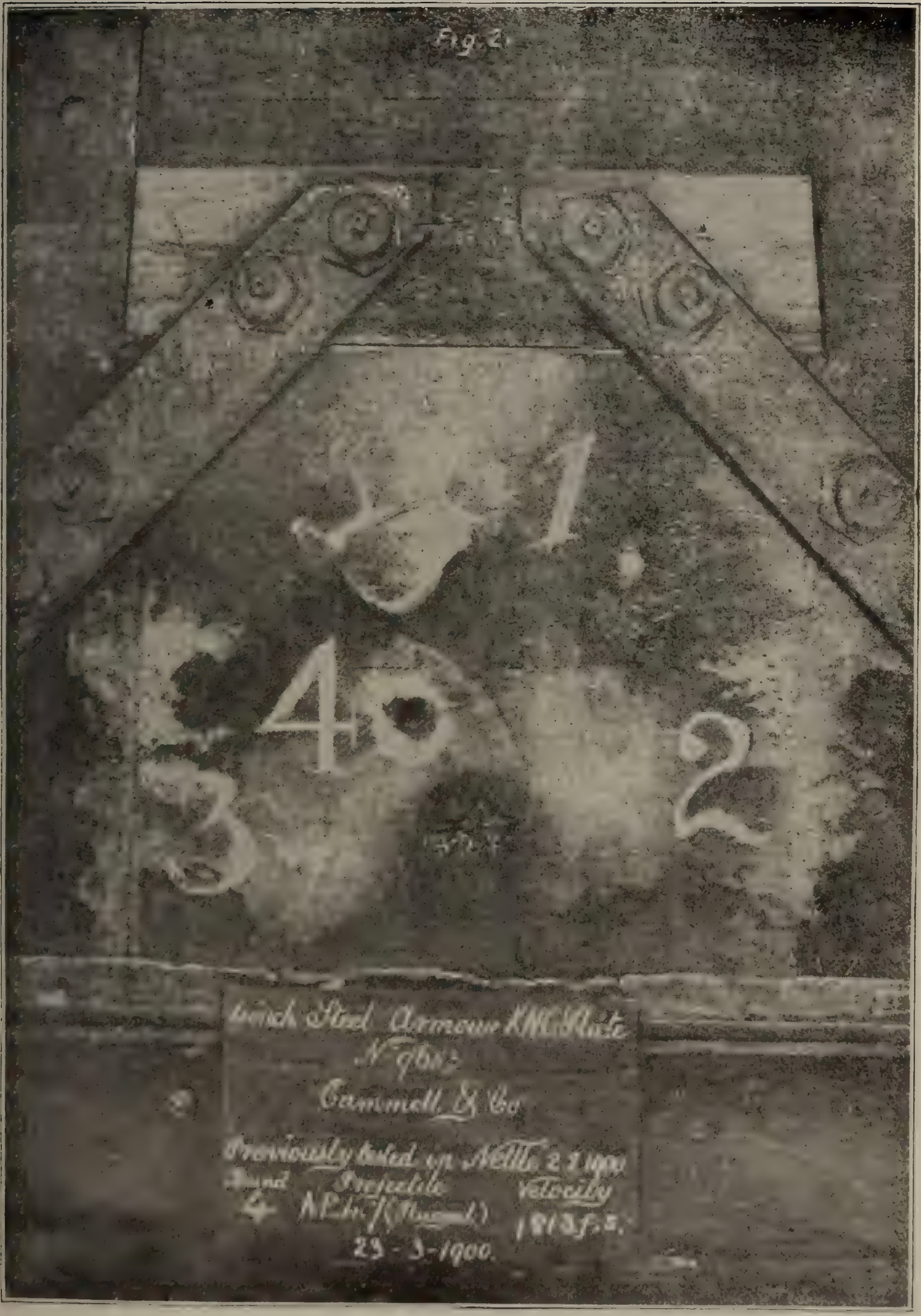
The second test is satisfactory, as showing how much this plate bore with success.

TEST OF A 6 INCH ARMSTRONG, WHITWORTH PLATE.

This firm submitted two plates early in 1900 for Admiralty tests, the plates being produced by the firm's special process. On July 3, 1900, these plates had a preliminary trial at the Government testing station on Whale Island, Portsmouth. The plates were of the normal size for trial purposes, viz, 8 feet by 6 feet and 6 inches thick. Five shots were fired at each plate with Holtzer armor-piercing shell at the velocities laid down for this thickness of plate in cemented steel. Both plates defeated all the projectiles, and were pronounced as satisfying in every respect the service requirements.



TEST OF A CAMMELL 4-INCH K. N. C. PLATE.



TEST OF A CAMMELL 4-INCH K. N. C. PLATE.

Front of plate.

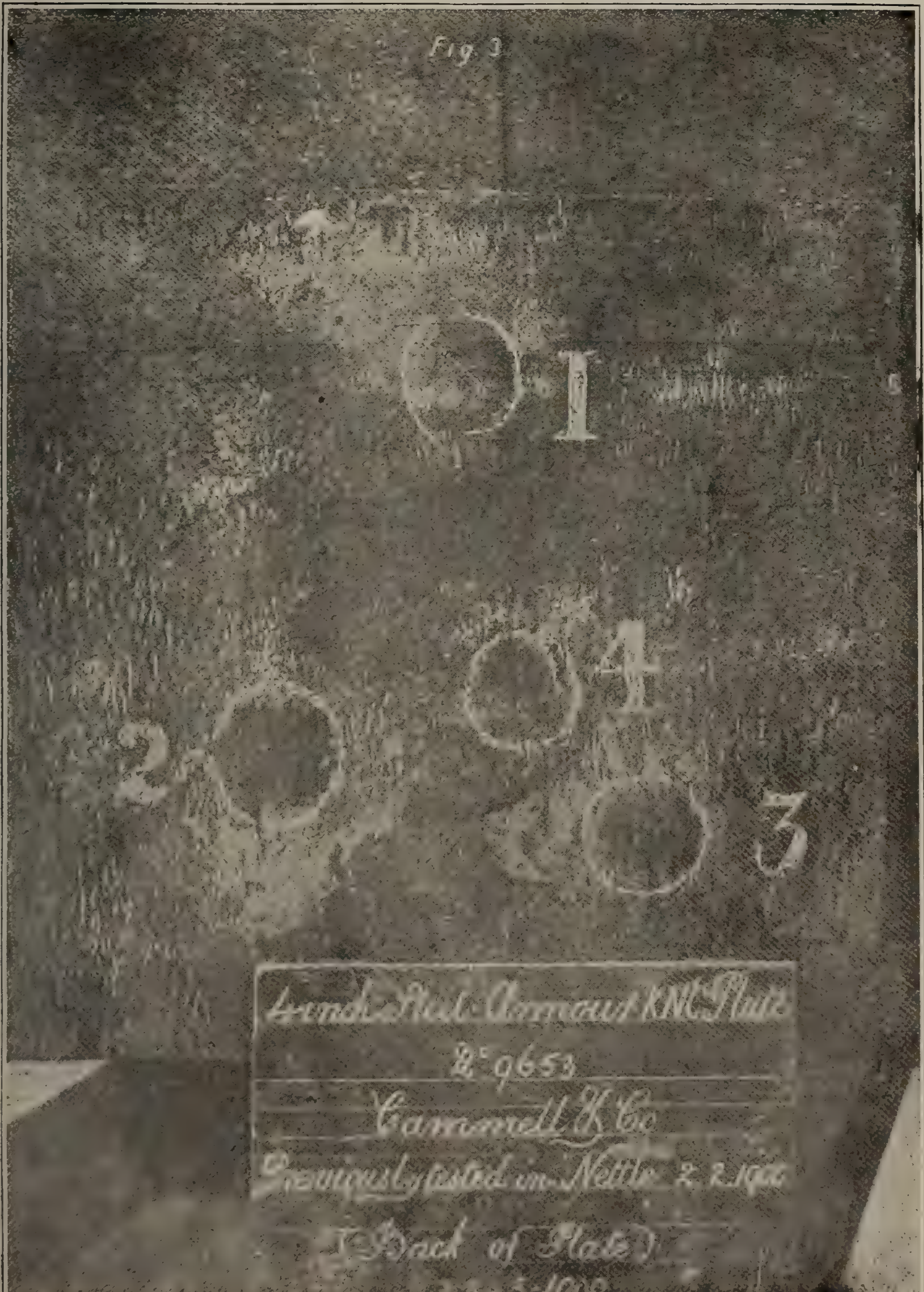
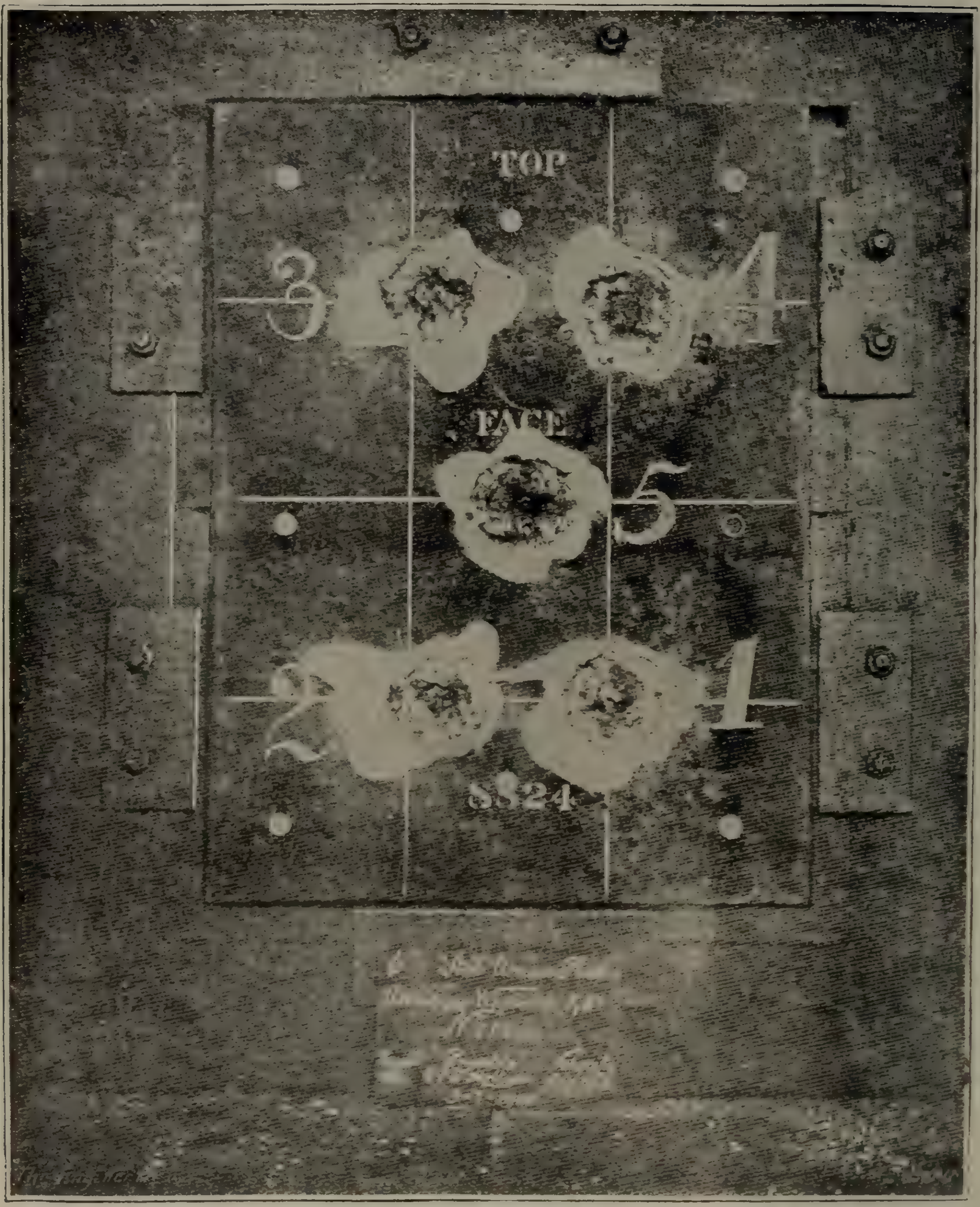


Fig 3
1
4
2
3
4 inch Steel Armour K.N.C. Plate
No 9653
Cammell & Co
Previously tested in Nettle 2.2.1900
(Back of Plate)
3-1900

TEST OF CAMMELL 4-INCH K. N. C. PLATE.

Back of plate.



TEST OF A 6-INCH ARMSTRONG, WHITWORTH & CO. PLATE.

Face of plate.

The following table is from the report of the trial:

Armor plate trials—Report on Armstrong, Whitworth & Co.'s 6 inch plate, tested at Whale Island on July 3, 1900.

[Thickness of plate, 6 inches; rounds fired, 5; backing, thickness, top and bottom, 3 feet 9 inches; center, 3 feet 8½ inches; secured by 8 bolts.]

Round.	Gun used.	Weight of projectile.	Point of striking.	Effect on front of plate.	Effect of striking on projectile.	Remarks.
1	6-in. R. F.	Holtzer, 100½ lbs.	2 feet from right edge and 2 feet from bottom.	Penetration, depth 2¾ inches; size of injury 19½ by 18½ inches.	Projectile broken up.	Striking velocity 1,998 foot-seconds, energy 2,768 foot-tons.
2	...do..	Holtzer, 100 lbs.	2 feet from left edge and 2 feet from bottom.	Penetration, depth 2⅝ inches; size of injury 23¼ by 14¾ inches. Slight surface crack toward right edge. Piece of projectile of round 1 jarred out.	.....do.....	Striking velocity 1,974 foot-seconds, energy 2,702 foot-tons.
3	...do..	....do...	2 feet from left edge and 2 feet from top.	Penetration, depth 2½ inches; size of injury (1) 12⅞ by 11½ inches, (2) 23¼ by 18¾ inches. Further scaling and surface crack to left edge developed in round 2. Further scaling.	.....do.....	Striking velocity 1,970 foot-seconds, energy 2,691 foot-tons.
4	...do..	....do...	2 feet from right edge and 2 feet from top.	Penetration, depth 2⅝ inches; size of injury (1) 12 by 11 inches, (2) 20¼ by 18¾ inches. Plate slightly bulged. Further scaling on round 3.	.....do.....	Striking velocity 2,024 foot-seconds, energy 2,841 foot-tons.
5	...do..	....do...	3 feet from right edge and 4 feet from bottom.	Penetration, depth 2½ inches; size of injury 21⅜ by 18½ inches. Surface crack upward to left upper corner toward No. 3.	.....do.....	Striking velocity 2,047 foot-seconds, energy 2,804 foot-tons.

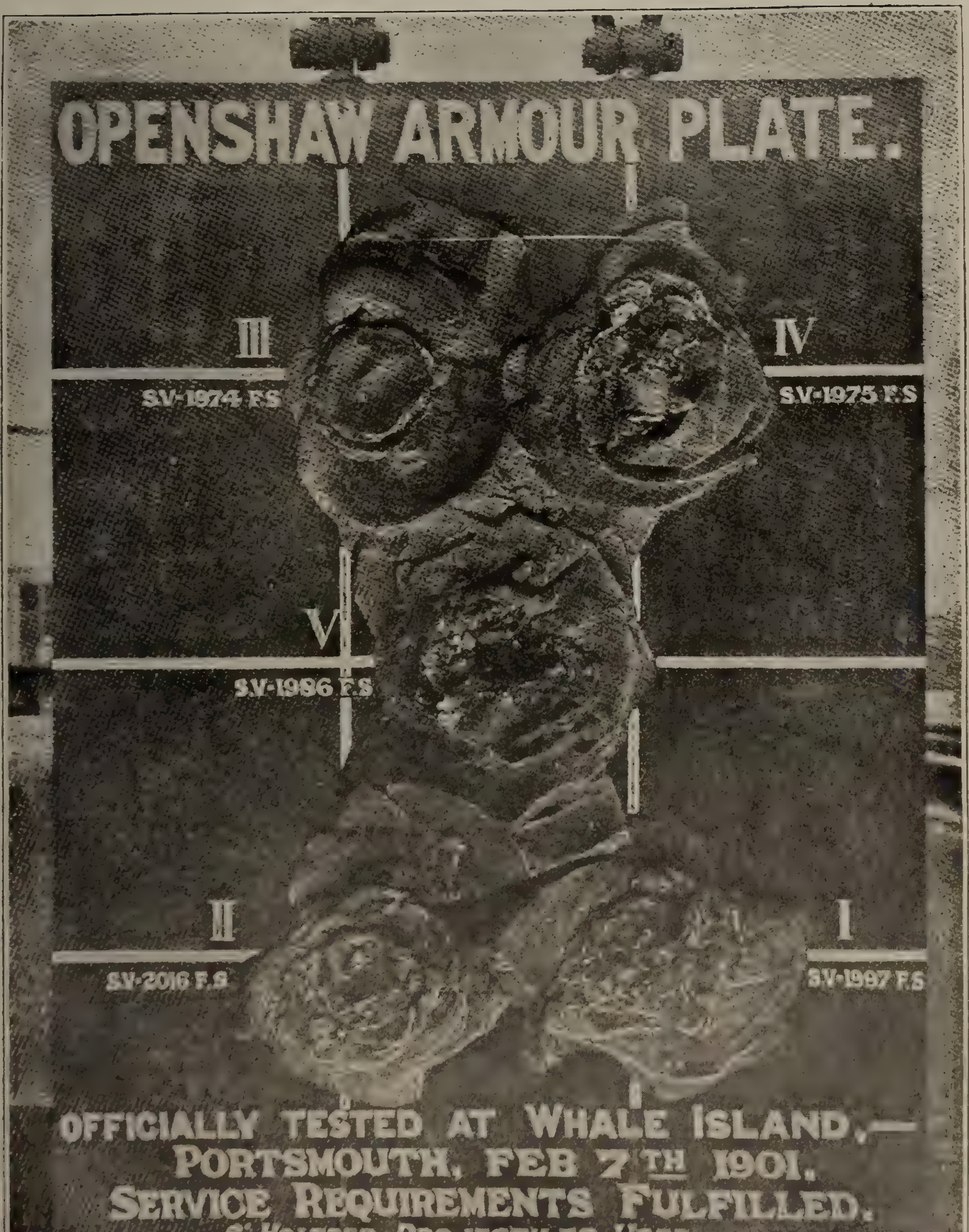
Further tests of the above plates were held on February 7, 1901, at Whale Island, Portsmouth, the plate being 8 feet by 6 feet, and 6 inches in thickness, secured by eight bolts to a backing 3 feet 10 inches thick.

The four official test rounds were fired by a 6-in. rapid-fire gun with 100-pound Holtzer projectiles at striking velocities ranging from 1,974 to 2,016 foot-seconds.

These four rounds having been fired, and the plate being neither perforated nor cracked, the firm's representative suggested the firing of a fifth shot at the center between the four previous shots, and the plate again passed through the ordeal without perforation or material damage. The plate shows unusual excellence, there being no really important fracture and but little bulging.

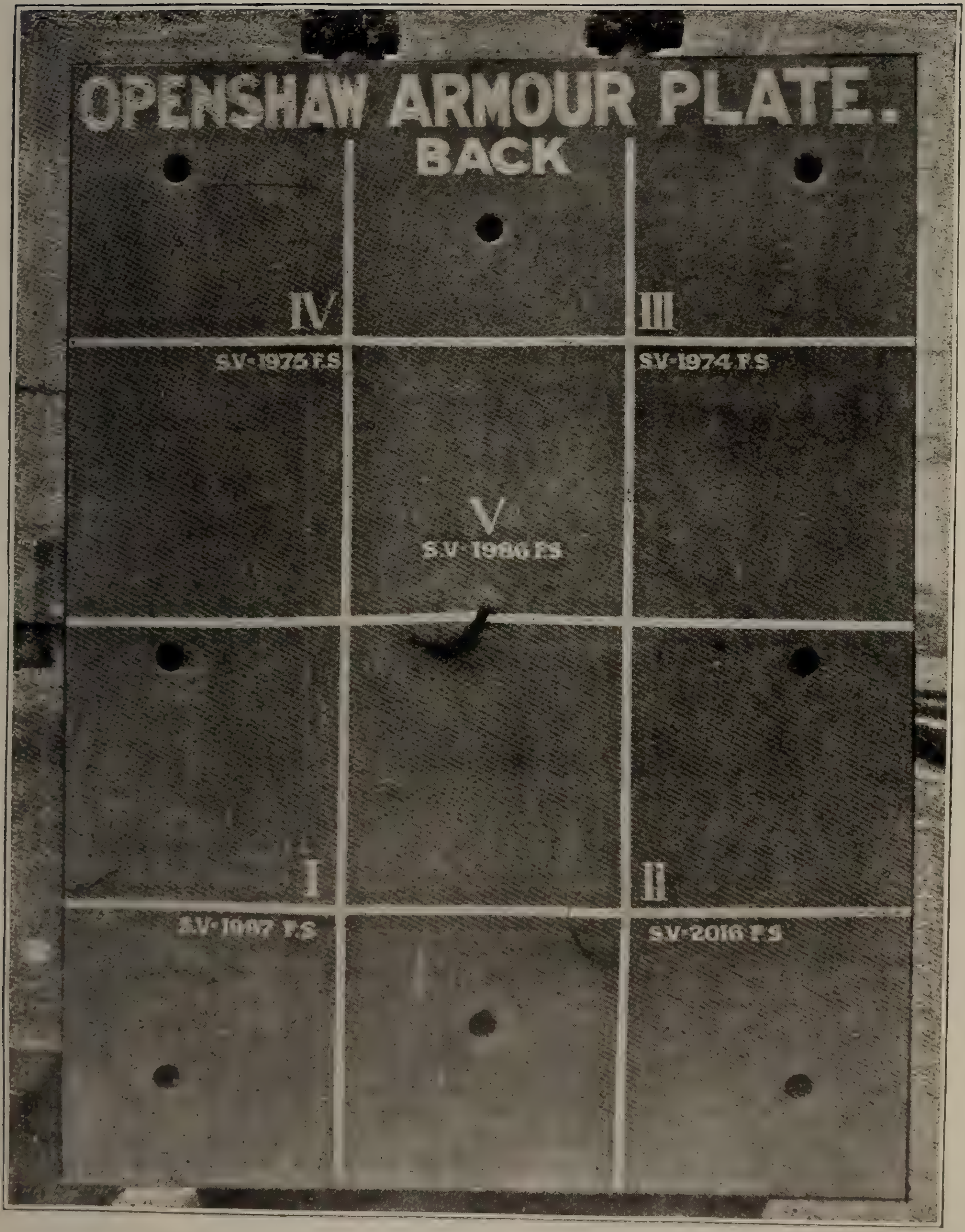
The following table gives the details of the respective rounds:

Round.	Gun used.	Weight of projectile.	Point of striking.	Effect on front of plate.	Effect of striking on projectile.	Remarks.
1	6-in. R. F.	Holtzer, 100½ lb.	2 feet from right edge, 2 feet from bottom.	Point of shot embedded. Maximum measurable depth of penetration 1¼ in., but after round 4, when point of shot had been shaken out, depth was 2.3 in.; inner circle of damage, 12 by 10 inches; face flaked off, 16 by 18 inches; no cracks. Surface shaken at under side and flaked off further at round 2.	Projectile broken up.	Striking velocity 1,997 foot-seconds, energy 2,779 foot-tons.
2	...do..	Holtzer, 100 lb..	2 feet from left edge, 2 feet from bottom.	Point of shot embedded. Penetration depth 1½ in., but after round 4, when point of shot had been shaken out, depth was 2.7 in.; inner circle of damage, 12 by 12 inches; face flaked off, 23 by 21 inches; no cracks. This round increased the flaking at round 1, and at round 3 the flaking of this round was increased.	....do......	Striking velocity 2,016 foot-seconds, energy 2,818 foot-tons.
3	...do..	Holtzer, 100½ lb.	2 feet from left edge, 2 feet from top.	Point of shot embedded. Penetration depth ¾ in., after point of shot had been shaken out, the depth was 1.6 in. to 1.7 in.; face flaked off, 15 by 12 inches; no cracks; flaking increased at round 2.	....do	Striking velocity 1,974 foot-seconds, energy 2,717 foot-tons.
4	...do..	Holtzer, 101 lb.	2 feet from right edge, 2 feet from top.	Point of shot embedded. Penetration depth, 1½ in.; face flaked off, 22½ by 20½ inches; no cracks. A crack now showed from right-hand edge of round 1 to right-hand edge of plate, depth not ascertained. Further flaking at round 3.	....do......	Striking velocity 1,975 foot-seconds, energy 2,732 foot-tons.
5	...do..	Holtzer, 100 lb.	3 feet from right edge, 4 feet from bottom.	Point of shot embedded. Penetration depth, 2.1 in.; face flaked off, 23 in. wide, but vertically the whole face between this and the preceding 4 rounds was flaked off, and also further flakings above rounds 3 and 4. Point of shot of round 4 shaken out.	....do......	Striking velocity 1,986 foot-seconds, energy 2,735 foot-tons.


OPENSHAW ARMOUR PLATE.
III
S.V-1974 F.S
IV
S.V-1975 F.S
V
S.V-1986 F.S
II
S.V-2016 F.S
I
S.V-1997 F.S
OFFICIALLY TESTED AT WHALE ISLAND,—
PORTSMOUTH, FEB 7TH 1901.
SERVICE REQUIREMENTS FULFILLED.
6" HOLTZER PROJECTILES USED.

TEST OF 6-INCH PLATE, ARMSTRONG, WHITWORTH & CO.

Front of plate.



TEST OF 6-INCH PLATE, ARMSTRONG, WHITWORTH & CO.

Back of plate.

TEST OF ARMOR PLATE FOR DUTCH BATTLESHIP DE RUYTER.

The following test of an armor plate intended for the battleship *De Ruyter* is as published by the Dutch press:

According to the contract, the nickel-steel plate, 3.3 meters (10.85 feet) long, 2.1 meters (6.9 feet) wide, and 15 centimeters (6 inches) thick, manufactured by the firm of Krupp after its own face-hardening process, was to be subjected to a test with a 15-centimeter (6-in.) gun. The Krupp steel armor-piercing projectiles to to be used at the trial, weighing about 45.5 kilograms (100 pounds) each, were to be furnished by the Dutch navy.

The contract further contained the following requirements:

The shots are to be fired normally against the plate.

The striking velocity is to be regulated according to the formula:

$$v=c \times 1530 \times \frac{a\,0.75}{p\,0.5}\,e\,0.7$$

in which

v=striking velocity in meters,
a=caliber of gun in decimeters,
p=weight of projectile in kilograms,
e=thickness of plate in decimeters,
c=coefficient.

This coefficient for a 15 centimeter (6 inch) plate is to be 1.38.

Three shots are to be fired, which, measured from center to center, are to be 55 centimeters (1 foot $9\frac{2}{3}$ inches) from each other, and the distance of any shot from the edge of the plate shall not be less than 55 centimeters (1 foot $9\frac{2}{3}$ inches).

None of these shots should perforate the plate, nor should any through cracks occur.

The plate shall then be fired upon with greater velocity so that perforation will take place, in order to determine whether the plate will crack when perforated.

The plate will be considered perforated when the rear end of the projectile penetrates to the back of the armor plate.

The plate was secured by eleven 65 millimeter (2.56 inch) armor bolts to a 60 centimeter (1 foot $11\frac{1}{2}$ inch) oak backing (two thicknesses of 30 centimeters ($11\frac{3}{4}$ inches) each), set up against an iron structure with a 40 millimeter (1.57 inch) skin (two thicknesses of 20 millimeters (0.78 inches) each).

For the fourth round the projectile had a striking velocity of 680.2 meters ($2,231\frac{2}{3}$ feet) corresponding to a muzzle energy of 22.91 meter-tons ($75\frac{1}{5}$ foot-tons) per centimeter of circumference of the projectile, and the expectation, based on the results of a former trial of a plate of the same thickness, was that perforation would occur, which, however, was not the case.

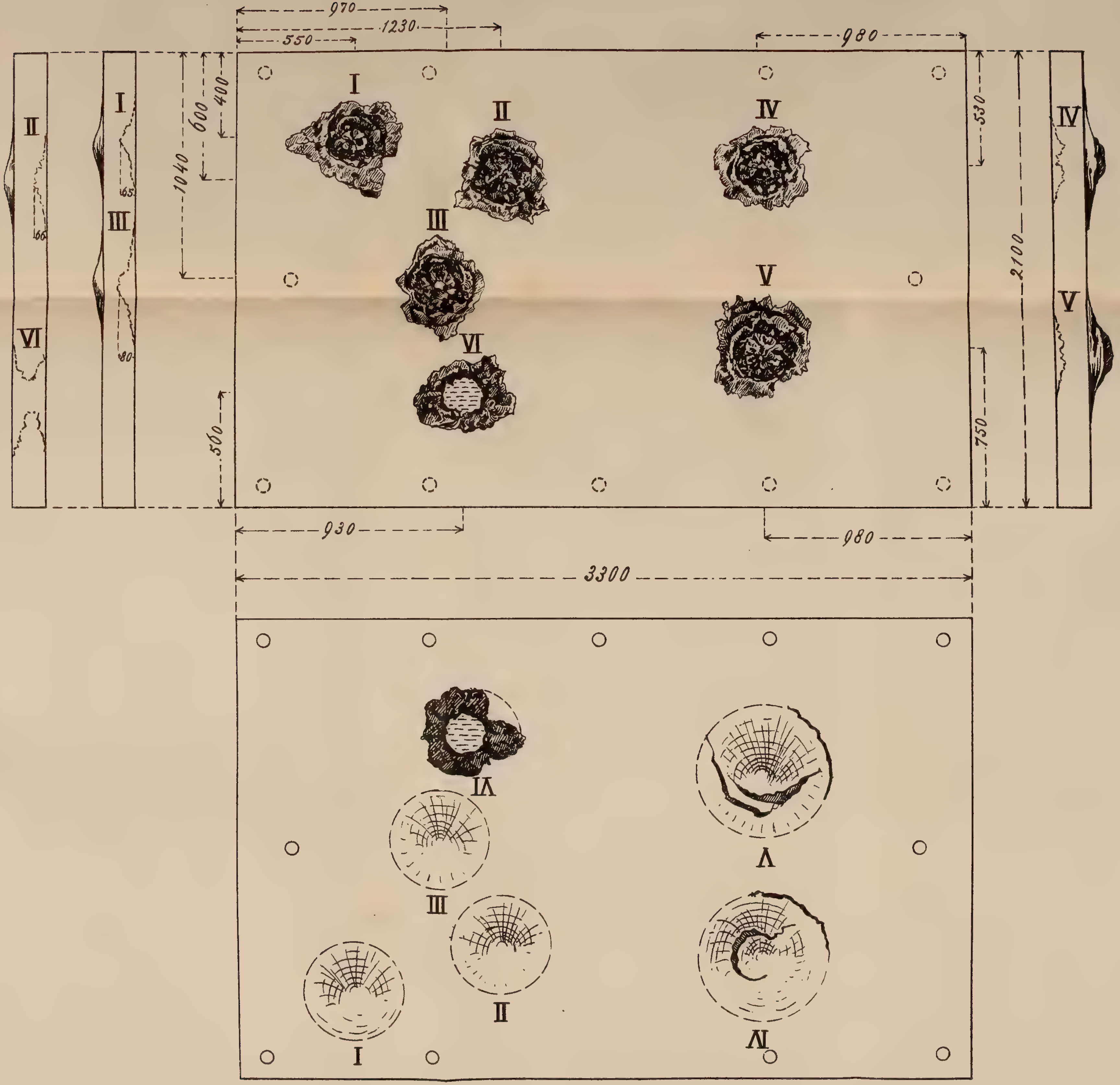
At the fifth round the velocity of the projectile and the muzzle energy were brought respectively to 701.6 meters (2,031 feet) and 24.37 meter-tons (80 foot-tons tons); yet the plate was not perforated. Penetration did not take place until the sixth round, when the velocity and energy were respectively 720.1 meters ($2,362\frac{1}{3}$ feet) and 25.67 meter-tons ($84\frac{1}{5}$ foot-tons).

The result of the trial is summed up in the following table and illustrated in the annexed plate.

Place and date of trial.	Angle of incidence.	No. of round.	Weight of projectile.	Striking velocity, per second.	Energy.			Effect of shot.		Distance from center to center of shot.
					Total.	Per cm. of circumference.	Per cm ^{2}. of area.	On plate.	On projectile.	
	Degrees.		*Kilos.*	*Meters.*	*Meter-tons.*	*Meter-tons.*	*Meter-tons.*			
Meppen, Dec. 3, 1900.	87	1	45.5 (100 lbs.)	555.8 (1,823 f. s.)	716.4 (2,349.80 f. t.)	15.29 (50.16 f. t.)	4.103 (13.46 f. t.)	Not perforated; no cracks Projectile entered plate to a depth of 65 mm. (2.56 in.). The front surface of the plate was broken loose over an area 250 mm. (9.84 in.) in diameter and indented 10 mm. (0.39 in.). From the hardened face, pieces 10 mm. thick and 40 mm. (1.57 in.) to 150 mm. (5.91 in.) wide were scaled off around point of impact. The back of the plate showed a bulge 30 mm. (1.18 in.) high and 450 mm. (1 ft. 5$\frac{7}{10}$ in.) in diameter.	Crushed	
Do	87	2	45.5	558.2 (1,830.9 f. s.)	722.6 (2,370.15 f. t.)	15.43 (50.62 f. t.)	4.138 (13.58 f. t.)	Not perforated; no cracks Projectile entered plate to a depth of 66 mm. (2.6 in.). Same as at round 1, the front surface was indented 10 mm. (0.39 in.) in places and the hardened face scaled off. The bulge at the back was 35 mm. (1.38 in.) high and 450 mm. (1 ft. 5$\frac{7}{10}$ in.) in diameter.	do	680 mm. (2 ft. 2¾ in.) between 1 and 2.
Do	87	3	45.5	565.7 (1,855.5 f. s.)	742.2 (2,434.4 f. t.)	15.84 (51.97 f. t.)	4.251 (13.94 f. t.)	Not perforated; no cracks Projectile entered plate to a depth of 80 mm. (2.7⅛ in.). Same as at round 2. The back showed a bulge 40 mm. (1.57 in.) in height and 425 mm. (1 ft. 4¾ in.) in diameter.	do	680 mm. (2 ft. 2¾ in.) between 1 and 3. 580 mm. (1 ft. 10⅞ in.) between 2 and 3.

Meppen, Dec. 3, 1900.	87	4	45.5	680.2 (2,231.1 f. s.)	1,073 (3,520.5 f. t.)	22.91 (75.14 f. t.)	6.145 (20.15 f. t.)	Not perforated; no cracks The depth to which the projectile entered the plate could not be determined, because the point of the projectile did not subsequently drop out of the plate, as in the case of the preceding rounds. The front surface was broken loose over a diameter of 270 (10⅗ in.) to 280 mm. (11 in.) and forced 30 mm. (1.18 in.) back. Same as at preceding rounds, the hardened face scaled off in places. The back of the plate on one side was forced 50 mm. (1.97 in.) back over a width of 220 mm. (8⅔ in.) bulging 50 mm. (1.97 in.) over a surface 600 by 600 mm. (1 ft. 11⅗ in.); this bulge broke loose over a length of 350 mm. (1 ft. 1⅘ in.).	Crushed	1,130 mm. (3 ft. 8½ in.) between 2 and 3.
Do	87	5	45.5	701.6 (2,301.25 f. s.)	1,142 (3,418.8 f. t.)	24.37 (79.95 f. t.)	6.538 (21.44 f. t.)	Not perforated; no cracks Same as at 4, the depth of the penetration could not be determined. Around the point of impact the material at the top was punched 50 mm. (1.97 in.) back, and further broken loose over a diameter of 250 mm. (9.84 in.) and forced back 25 (0.98 in.) to 40 mm. (1.57 in.). Face scaled off as at previous rounds. The back of the plate was punched back 50 mm. (1.97 in.) and bulged 70 mm. (2.76 in.) over a surface of 600 by 600 mm. (1 ft. 11⅗ in.). This bulge was broken at the bottom over a length of 350 mm. (1 ft. 1⅘ in.) and forced back 10 mm. (0.39 in.).	do	

Place and date of trial.	Angle of incidence.	No. of round.	Weight of projectile.	Striking velocity per second.	Energy.			Effect of shot.		Distance from center to center of shot.
					Total.	Per cm. of circumference.	Per cm². of area.	On plate.	On projectile.	
	Degrees.		*Kilos.*	*Meters.*	*Meter-tons.*	*Meter-tons.*	*Meter-tons.*			
Meppen, Dec. 3, 1900.	87	6	45.5	720.1 (2,361.95 f. s.)	1,203 (3,947 f. t.)	25.67 (84.22 f. t.)	6.887 (22.59 f. t.)	Perforated; no cracks. The material punched out from the plate passed through the first layer of the wooden backing and penetrated to a depth of 25 cm. (9.84 in.) into the second layer. The hardened face of the plate sealed off as at preceding rounds.	Crushed	490 mm. (1 ft. 7¼ in.) between 3 and 4.



TEST OF ARMOR PLATE FOR BATTLESHIP DE RUYTER.

TEST OF ARMOR PLATE FOR DUTCH BATTLESHIP KONINGIN REGENTES.

This test took place April 28, 1900.

The nickel-steel plate 3.3 meters long, 2.2 meters wide, and 25 centimeters thick, manufactured by the firm of Krupp, and face-hardened after its own process, was, under the contract, to be subjected to a test with a 24-centimeter gun. The armor-piercing projectiles to be used at the trial were to have a weight of about 215 kilograms (474 pounds) each.

For other requirements of the contract see Test of Plate for Dutch battleship *De Ruyter*, which are identical.

The coefficient *c* for a 25 centimeter plate will be 1.35.

Three shots are to be fired, which, measured, from center to center, are to be 75 centimeters (29.5 inches) from each other and not less than the same distance from the edge of the plate.

The plate will be considered perforated when the rear end of the projectile penetrates to the back of the armor plate.

The plate was secured by means of twelve 75-millimeter nickel-steel bolts to a 60-centimeter (2 of 30 centimeters) oak backing set up against an iron structure with a 40-millimeter (2 of 20 millimeters) skin.

Shots 1 to 5 demonstrated that the contract requirements had been complied with.

For shot 4 a capped steel shell was used.

The results of the test are shown in the following table:

Place and date of trial.	Angle of incidence.	No. of shot.	Weight of projectile.	Striking velocity.	Energy.			Effect of shot		Distance from center to center of shot.
					Total.	Per cm. of circumference.	Per cm². of area.	On plate.	On projectile.	
	Degrees		*Kilos.*	*Meter sec.*	*Meter tons*	*Meter tons*	*Meter tons*			
Meppen, Apr. 28, 1900.	90	1	213.3	526.8	3,017	40.02	6.669	Not perforated; no cracks The face of the plate was broken loose over a diameter of 360 to 450 mm. and forced back 5 to 15 mm. From the hard face pieces 10 to 60 mm. thick and 50 to 250 mm. wide were sealed off all around The back of the plate showed a bulge 30 mm. high and 600 mm. in diameter.	Crushed	
Do	90	2	213.7	518.9	2,933	38.90	6.482	Not perforated; no cracks The face of the plate was broken loose over a diameter of 350 mm. and forced back 5 to 10 mm. From the hard face pieces 10 to 40 mm. thick and 100 to 300 mm. wide were sealed off all around. The back of the plate showed a bulge 40 mm. high and 700 mm. in diameter, with a crack 700 mm. long and 50 mm. deep.	do	Between 1 and 2 800 mm.
Do	90	3	214.7	516.5	2,919	38.72	6.453	Not perforated; no cracks The face of the plate was broken loose over a diameter of 400 to 450 mm. and pressed back 5 to 10 mm.	do	Between 2 and 3, 750 mm. Between 1 and 3, 750 mm.

								From the hard face of the plate pieces 10 to 70 mm. thick and 100 to 200 mm. wide were scaled off all around. The back of the plate showed a bulge 30 mm. high and 600 mm in diameter.		
Meppen, Apr. 28, 1900.	90	4	[1] 170	604.2	3.163	41.95	6.992	Perforated; no cracks. The projectile perforated the plate, backing, and inner skin and damaged parts of the structure. The shell was found 600 m. back and 180 m. to the right of the structure. The pieces punched out of the plate were found embedded in the iron structure supporting the plate. From the hard face pieces 20 to 40 mm. thick and 50 to 100 mm. wide were scaled off. At shots 1, 2, and 3 additional pieces were scaled off the hard face. From 2 to the left-hand edge and from 1 to the upper edge two fine cracks 70 to 100 mm. deep developed.	Not broken; horizontally the projectile was indented 28.8 mm.	Between 3 and 4, 1,060 mm.
Do.	90	5	213.3	577.2	3.622	48.04	8.006	Not perforated. The plate broken loose all around and forced back 70 mm. From the hard face pieces 10 to 50 mm. thick and 50 to 200 mm. wide were scaled off. At 1, 2, and 3 further material scaled off. From 5 to 4 a fine surface crack developed; toward the lower edge of the plate appeared two small cracks 70 mm. deep. The back of the plate remained in place over a width of 650 mm.; the remaining part, over a diameter of about 750 mm., was turned up 30 mm.	Crushed	Between 4 and 5, 1,000 mm. Between 3 and 5, 1,100 mm.

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[1] With cap: weight of cap 11.2 kilograms.

Place and date of trial.	Angle of incidence.	No. of shot.	Weight of projectile.	Striking velocity.	Energy.			Effect of shot.		Distance from center to center of shot.
					Total.	Per cm. of circumference.	Per cm². of area.	On plate.	On projectile.	
	Degrees		*Kilos.*	*Meter sec.*	*Meter tons*	*Meter tons*	*Meter tons*			
Meppen, Apr. 28, 1900.	90	6	213.1	607.2	4,004	53.11	8.851	Perforated .... The plate and the backing, the latter being already much damaged, were perforated. As the plate afforded no more space, this shot struck 500 mm. from shot 4 and 500 mm. from the right-hand edge of the plate. Moreover, the support having already been much damaged by shot 4, the right-hand corner was cracked off and bent back.	Crushed	Between 4 and 6, 500 mm. Between 5 and 6, 900 mm.

SWEDISH ARMOR TRIALS.

The following notes on Swedish armor trials are from the press publications of that country:

In the trials of Bofors turrets, referred to below, the projectiles used were ordinary 12-centimeter (4.72-in.) and 15-centimeter (5.91-in.) shell with bursting charges, and 15-centimeter cast-iron shell with bursting charges and base fuses M/84, which were made to explode against a sheet-iron plate placed 3 meters (9.84 inches) forward of the turret. The results are shown in the following two tables:

Trials of a 15 centimeter (5.91 inch) fixed turret for battleships A, B, and C, held at Bofors January 27, 1900.

No. of round.	Caliber of gun.	Weight of projectile.	Striking velocity.	Per cent according to De Marre.	Effect on projectile.	Penetration.	Effect on plate.
	cm.	*Kilos.*	*Meters.*			*mm.*	
1	12 (4.72 in.)	21 (46.30 lbs.)	399.9 (1,311.95 ft.)	102.3	Whole	190 (7.48 in.)	No cracks.
2	12	21	400 (1,312 ft.)	100.2	do	190 (7.48 in.)	Do.
3	12	21	401.3 (1,316.26 ft.)	102.6	do	182 (7.16 in.)	Do.
4	12	21	405.3 (1,329.38 ft.)	102.3	do	191 (7.52 in.)	Do.
5	12	21	409.3 (1,342.51 ft.)	104.6	Point broken.	328 (12.91 in.)	Do.

NOTE.—Upon comparing the figures relating to the striking velocity with those relating to the percentage, the latter may be found incorrect; but this apparent discrepancy is due to the fact that the thickness of the turret, according to measurements made after the trial, varied, within the limits permitted, between 103 and 106 millimeters (4.05 and 4.17 inches), and the computation of the velocity is based on these figures and not uniformly on 100 millimeters (3.94 inches).

Trials of 15 centimeter (5.91 inch) fixed turret, held at Carlskrona, June 20, 1900.

[Thickness of turret, 100 millimeters (3.94 inch).]

No. of round.	Caliber of gun.	Kind and weight of projectile.	Striking velocity.	Per cent according to De Marre.	Effect on projectile.	Penetration.	Effect on plate.
	cm.		*Meters.*			*mm.*	
1	12 (4.72 in.)	Cast-iron shell, bursting charge 20.9 kilos (46.07 lbs.).	600.8 (1,970 ft.)	156	Shattered.	45 (1.77 in.)	4 small cracks occurred.
2	15 (5.91 in.)	Cast-iron shell, bursting charge 45.3 kilos (100.3 lbs.).	418.4 (1,372 ft.)	133	.....do....	26 (1.02 in.)	No cracks.
3	15 (5.91 in.)	.....do............	514.7 (1,688 ft.)	156	.....do....	55 (2.16 in.)	A crack occurred at each point of impact of preceding rounds. Turret slid about 120 mm. (4.72 in.) back.
4	15 (5.91 in.)	Armor-piercing shell M/84, bursting charge 46 kilos (101.5 lbs.).	508.9 (1,670 ft.)	......	Shattered against sheet-iron plate.	60 (2.36 in.)	Besides the point, there were 4 smaller impressions from fragments. A crack around point of impact of round 3. On inside of turret 2 cracks back of impact of point of projectile.

Trials of a 100 millimeter (3.94 inch) Krupp noncemented plate, held at Carlskrona June 28 and 29 and July 2, 1900.

No. of round.	Caliber of gun.	Kind and weight of projectile.	Striking velocity.	Per cent according to De Marre.	Effect on projectile.	Penetration.	Effect on plate.
	cm.	*Kilos.*	*M.*	*P. ct.*		*mm.*	
1	12 (4.72 in.)	21 (46.30 lbs.)	408.8 (1,341 ft.)	106	Fractured.	23 (0.90 in.)	No cracks.
2	12	21	467.8 (1,535 ft.)	125	....do.....	15 (0.59 in.)	Do.
3	12	21	561.8 (1,843 ft.)	146	....do.....	....	A round crack. Same around point of impact of preceding round. Back bulge with two cracks 11 millimeters (0.43 inch) wide.
4	15 (5.91 in.)	[1]	515.3 (1,690 ft.)	165	Shattered.	45 (1.77 in.)	Eight straight cracks around points of impact of rounds 1 and 2. Back bulge with cracks.
5	12	21	395.4 (1,297 ft.)	104	Fractured.	11 (0.43 in.)	No cracks; no back bulge.

[1] Armor-piercing shell M/84, bursting charge 45.6 kilos (100.52 pounds).

The fifth round was fired for the purpose of ascertaining in how far a hit near the seam between two plates would bring out any weakness, and whether in this respect the Bofors turrets cast in one piece show superiority. The point of impact was therefore fixed as near the edge as the method of setting up the plate and other circumstances permitted, namely, 130 millimeters (5.12 inches) from the edge of the plate—that is to say, as regards the point of the projectile. From the circumference of the latter it was only 70 millimeters (2.76 inches) to the edge. In order to get the shot so near the edge, the frame piece supporting the plate had to be removed and replaced by an oak beam, into which a notch was moreover cut for the projectile. The plate was therefore not strongly supported; it nevertheless stood the test remarkably well. This becomes especially apparent by a comparison of this fifth round with the last round fired at the Bofors trial on January 27, 1900. The percentage of the two shots, according to De Marre's formula, is practically the same—104.6 in one case and 104 in the other. But as far as the resisting power is concerned, it is obvious that the Krupp noncemented plate is far superior to the Bofors armor. In view of this fact we can but hope that Bofors material in its present state will not again be used as armor for our fighting ships. The weight and consequently the thickness of armor is limited, and it is therefore absolutely necessary that we should acquire it where the most effective protection can be had, even though for the present that is unfortunately abroad. It is possible, however, and even probable, that Bofors, or some other Swedish works, will, by applying the Krupp process to home material, in time attain equally good results, so that the thinner armor at least can be furnished in our own country.

Trial of the citadel armor for battleships A, B, and C at Meppen, May 29, 1900.

The dimensions of the trial plate, a Krupp cemented, or, as he himself calls it, a face-hardened nickel-steel plate, were 2 by 1.5 by 0.175 meters (6.56 by 4.92 by 0.57 feet). It was secured by six bolts to an oak backing 2 by 30 centimeters (0.79 by 1.18 inches). The projectiles used were 15-centimeter (5.91 inches) armor-piercing shell M/88 of Finspong steel.

No. of round.	Caliber of gun.	Weight of projectile.	Striking velocity.	Per cent according to De Marre.	Effect on projectile.	Penetration.	Effect on plate.
	cm.	*Kilos.*	*Meters.*	*P. ct.*		*mm.*	
1	15 (5.91 in.)	45.45 (100.20 lbs.)	646.3 (2,120 ft.)	141	Fractured	105 (4.13 in.)	No cracks; face sealed off over an area of about 30 centimeters (11.8 inchs); back bulge, 39 millimeters (1.53 inches) high.
2	15	45.4 (100 lbs.)	629.3 (2,064 ft.)	138	.....do....	81 (3.19 in.)	Same as at preceding round; back bulge, 24 millimeters (94 inch) high.
3	15	45.4	629.3	138	.....do....	....	Diameter of surface sealed off, 18 centimeters (7.09 inches); back bulge. 30 millimeters (1.18 inches) high.

Trial of 21-centimeter (8.27 inch) turret for battleships A, B, and C, at Meppen, July 27, 1900.

Dimensions of trial plate, 1.8 by 1.8 by 0.19 meters (5.91 by 5.91 by 0.62 feet), curved to a radius of 1.75 meters (5.74 feet) and secured by 25 bolts to an inner skin 12 millimeters (0.47 inches) thick. The projectiles, made for that purpose at Bofors, were 17 centimeters (6.69 inches) armor-piercing steel shell.

Number of round.	Caliber of gun.	Weight of projectile.	Striking velocity.	Per cent according to De Marre.	Effect on projectile.	Penetration.	Effect on plate.
	cm.	*Kilos.*	*Meters.*	*P. ct.*		*mm.*	
1	17 (6.69 in.)	77 (169.75 lbs.)	558.2 (1,831 ft.)	137	Fractured	45 (1.77 in.)	No cracks; face scaled off over an area 25 by 22 cm. (9.84 by 8.66 in.); back bulge, 23 mm. (0.91 in.).
2	17	76.9 (169.52 lbs.)	557.2 (1,828 ft.)	136	.....do....	45	Same as at round 1; back bulge, 17 mm. (0.67 in.).
3	17	76.8 (169.3 lbs.)	556.2 (1,825 ft.)	136	.....do....	50 (1.97 in.)	Same as at round 1; back bulge, 20 mm. (0.78 in.).

CHANGES IN ARMOR PROTECTION.

The change in the last score of years is well shown by the designs of British battleships. The desire has been to increase protection, as much as other necessities would permit, by increasing the length of the broadside belt and widening it, while at the same time improving the protection of the guns and gunners.

Fifteen years ago the armor protection of a ship consisted of a short water-line belt, which was not greater in length than one-third or about 40 per cent of the total length of the ship, while the main guns were protected by pear-shaped barbettes, the secondary armament having only shields of from 2 to 3 inches in thicknesss. It will thus be seen that not only was the part above the armored citadel in the center of the ship unprotected, but also the ends of the ship before and abaft the citadel.

This is the main feature of the protection of the vessels of the 1880–1885 date. Then the main belt was increased in length to 65 per cent and in thickness to 18 inches, and a supplementary armor of 5 inches constructed above the main belt, carrying the armor to the height of the main deck; 6 inch casemates also inclosing the 6-in. main-deck guns, and 6 inch shields for the upper-deck 6-in. guns. The next step, upon the introduction of the Harvey armor process, was the use of 9 inch armor for the broadside protection, this being found equal to the old 15 inch compound plate; therefore it was found to be possible to give a 9 inch broadside armor of 55 per cent length and in height from below the water line to the main deck, with the 6 inch supplemental armor above.

In the next stage the side armor was reduced to 6 inches and extended in reduced thickness to 2 inch nickel steel to the bow, on account of the liability of the bow being punctured and thus destroying the handiness of the vessel, and also for the purpose of strengthening the ram.

In the latest types the bow armor tapers from 4 inches to 2 inches, while aft there is 1 inch of nickel steel over the shell plating. The 7 inch Krupp cemented steel plate has taken the place of the 9 inch Harvey plate.

The following table, published in part in *Engineering*, of London, shows this evolution, the causes being due to the improvement in the quality of armor, coupled with special needs regarding displacement, draught, radius of action, etc., a compromise in each case being made:

Armor protection of British battleships.

Date.	Ship.	Thickness of armor, in inches.	Weight of armor, in tons.	Displacement of vessel, in tons.	Percentage of armor to displacement.	Length of vessel, in feet.	Length of belt, in feet.	Percentage of length of belt to length of vessel.	Depth of main armor.	
									Ft.	*in.*
1881	Inflexible	16–24, iron	2,450	11,880	20.8	320	110	34.3	15	8
1886	Collingwood	8–18, compound.	1,780	9,500	18.7	325	140	43	15	8
1892	Royal Sovereign	do	2,900	14,150	20.5	380	248	65.2	15	1
1895	Majestic	9, Harvey.	2,790	14,900	18.7	390	217	55.6	15	0
1899	Canopus	6, Harvey.	1,740	13,090	13.3	390	198	50.7	14	0
1900	Duncan	7, Krupp.	2,000	14,000	14.3	405	285	70.3	14	0

The *Engineer* of London has published some notes and observations on the armor exhibit at the Paris Exposition, some extracts from which are taken to show the kinds and varieties of armor still manufactured for different purposes.

The display at the exposition showed the massive armor rising to the possible limit of thickness, then the compound armor, and after that the reduction in thickness and the refinement and hardening of the face for various purposes.

To reduce weight and increase the power of resistance are the two great aims of modern makers of armor plate.

All the progress made in this branch of metallurgy during the last twenty years is based on the physical character of the steel, and the power of resistance is increased by various alloys and methods of production.

The following different types of plates were exemplified at the exposition:

1. *Extra soft metal*, characterized by perfect homogeneity and a higher grade of ductility than that of puddled iron, possessing at the same time a greater power of resistance to perforation, exceeding that

of iron by about 15 per cent. Such metal, on account of its high malleability, is to-day exclusively adopted in the French navy in the construction of armored decks.

2. *Iron plates.*—The use of puddled iron for protective plates has, as before remarked, entirely disappeared in naval construction, and is only used to a limited extent in land fortresses, but the use of wrought iron for this purpose has survived until the present. Many cupolas made in France during the past ten years for foreign governments, especially in Belgium at the intrenched camps of Namur and Liege; in Roumania, for those of Bucharest; in Switzerland, Denmark, and elsewhere are fitted with wrought-iron roofs in spite of the fact that soft steel had given far better results than the iron. There is, however, a reason for this adhesion to apparently inferior material. In the course of comparative experiments in France to determine the relative values of iron and soft steel to resist the effects of high explosives, it was found that with the detonation of a charge of melinite in contact with soft steel and iron plates the damage sustained was much greater with the former than the latter, and it was the result of such experience that decided the continued use of the iron for the purposes named. This somewhat contradictory result is due to the fibrous character of the iron, which enables it to resist the effect of sudden shocks by distributing the strain over a larger area than is possible for a crystalline structure. With cast metal having a homogeneity and local strength much greater than that of the iron, the physical structure is not able to distribute the effect of the sudden explosion, and this being concentrated in its intensity, the resulting damage is much greater. Probably the same differences would not exist in steel plates containing a relatively high proportion of nickel, which appears to give a fibrous texture and thus to endow the plate with the advantage of greater tenacity, besides the perfect homogeneity characteristic of the steel.

3. *Chilled cast iron.*—This material has never found any application in the armor plating of ships; on the other hand, it has been, and is, very extensively used in the construction of land defenses. Reduction of weight being of no importance for such work, it can be employed of any thickness that may be found desirable, while complicated forms can be obtained, and a power of resistance to attack that is quite remarkable. On account of these characteristics it is specially suitable for casemates, the fixed walls of revolving turrets, etc. The chilled surface obtained by the process of manufacture is sufficiently hard to insure the breaking up of cast-iron projectiles and even of chilled-iron shells; crucible chrome-steel shells, however, are able to break up the hardened surface, and with the introduction of this means of attack the chilled-iron plate has lost much of its value as a method of defense. In the circular form of the land fort an additional

safety was obtained from the fact that it was almost impossible for a shot to strike normally to the plate, and the ogival head of the projectile glanced off after plowing a furrow on the hardened surface. This advantage, however, is now lost by making the chrome-steel projectile cylindrical and flat-headed instead of pointed. With such an attack the hardest plate can be very speedily shattered. For this reason it appears evident that the chilled cast-iron plate must be abandoned as a means of land defense, and give place to cast steel possessing higher tenacity.

4. Cast steel.—This material, which is now finding an increased application for the outer works of armor-clad land forts, is also employed for the roofs of cupolas in comparatively thin plates. This metal has been subjected to the standard tests of the French navy for deck armor plates, and has passed through these tests without showing any cracks or tears. These trials show in a remarkable way the improvements that have been made in the manufacture of cast steel of that special quality required to resist such tests as those imposed, proving that the metal possesses a degree of tenacity not supposed possible to obtain.

5. Ship armor.—Extra soft plates. This quality of steel was produced after a long and costly series of trials, the metal possessing a malleability that had seemed to be the exclusive characteristic of puddled iron. The results obtained led the French navy to adopt cast metal for armored deck plates; and all the armor-plate manufacturers in France soon arrived at the satisfactory production of such plates.

6. Special steel.—Chrome-nickel alloys. The chief interest at present is centered round chrome-nickel steel, which, under the name of "special steel," has been rapidly substituted for all other mixtures, and which, in addition to the deck plates, was met with in almost all the plates exhibited at the exposition. This mixture undoubtedly presents certain well recognized advantages, which induced makers to quickly adopt it, in spite of the serious difficulties which the manufacture of the blooms undoubtedly presents. The beneficial effect of the addition in diminishing the tendency to break up and preventing the formation of cracks has been undoubtedly proved by trials; but, in spite of this, nickel hardly affected the power to resist perforation. It seemed, therefore, expedient to endeavor to increase this power. The makers faced this question, and with a considerable measure of success, by the use of chromium in combination with nickel. They have succeeded on these lines in producing a special steel, possessing a resistance considerably in excess of that of ordinary steel to the extent of increasing the velocity of perforation by about 12 per cent and presenting an altogether remarkable absence of fragility.

On the other hand, the manufacture of this metal is a very delicate matter, as previously mentioned, for the blooms and the rough billets become rapidly covered with surface crust, which, in forging, becomes furrowed, and the surface is nothing more than a mass of wrinkles; for this reason the works which treat this metal have recourse to special processes to avoid these drawbacks. A plate prepared in this way for Russia showed a very distinctly marked superiority over nickel steel.

This metal is used by the French navy in the manufacture of plates which can not be made of cemented steel, the process of tempering cemented steel plates producing deformations, which in some cases can not be corrected. Such cases are found in thick and considerably bent plates, such as those for the extreme forward part of an armor belt, or in relatively thin plates, 4 inch or less, and which are peculiarly liable to deformation.

7. *Hardened steel.*—If the proportion of chromium be increased above 2 per cent, a metal is produced more resisting than ordinary special steel and yielding a velocity of perforation considerably greater, in fact surpassing that of ordinary steel from 20 to 25 per cent. This hardened steel is specially used in the preparation of plates for gun shields with a thickness of from 1$\frac{3}{16}$ inches to 4$\frac{3}{4}$ inches, for the protection of gun crews and ammunition supply, and for the roofs of turrets. Very thin shields of from five thirty-seconds of an inch to thirteen sixty-fourths of an inch are also made from this metal for shelters against musketry. Generally these plates of hardened steel present the greatest possible rigidity and are free from a tendency to break up. Projectiles fired against them generally rebound without producing any damage, even at short range. Nickel gives tenacity, while the chromium alone adds to the resistance.

8. *Cemented steel.*—Cementation, as is generally known, is the process which is adopted at the present time in the works producing armor plates to increase the resistance of such armor by means of surface hardening sufficient to insure the breaking up of the projectiles fired against it, though the latter be themselves made from crucible steel of the greatest hardness. It has been stated above that on account of the difficulties of shaping it, it was practically impossible to increase the hardness of "special steel" so as to impart increased resistance, and it was therefore imperative to have recourse to some other method. Cementation offered an indirect solution of the problem by furnishing the means of indefinitely increasing the surface hardness of the plates. Whatever may be said to the contrary, the advantages of cementation are such that this process is nowadays adopted in all the great armor-plate works.

This cemented steel is a special metal, the surface of which is hardened by a cementing process at a high temperature, and continued long enough to penetrate to a depth of about an inch. The cementation process is followed by tempering with jets of cold water striking on the prepared surface. This imparts great hardness to the cemented surface, so that it can not be touched by a cutting tool. A plate so prepared may break up a hard chrome-steel shell. As the plate, apart from its cemented surface, is of relatively soft steel with a slight dosage of chromium, it can be worked almost as easily as the special steel as long as it is not tempered, so that plates of maximum thickness can be made by this process, while the thin plates are made exclusively from hard steel with a larger proportion of chromium. Such cemented plates can generally be depended on to break up chrome-steel projectiles when these latter are not fired with a velocity sufficient to traverse the cemented surface without themselves breaking up, and it may be estimated that this metal possesses a velocity of perforation more than 50 per cent greater than that of ordinary steel.

This high power of resistance, however, is considerably reduced when the attacking projectile is "capped," which often enables it to penetrate the cemented surface without breaking, and in such a case the velocity of perforation must be taken at from 35 to 40 per cent, instead of 50 per cent, when compared with ordinary steel. Wherever possible, cemented steel is used for the thickest armor plates.

The original cementation process applied to armor plates is due to Harvey, and his process is, for the most part, followed by manufacturers. At some works, however, modifications have been introduced with a view to increasing the resisting power of the plates. Thus, Creusot has adopted a gas process, and Krupp has made important changes that have largely increased the tenacity of the plates. The Italian works of Terni have adopted a process securing similar advantages.

MANIPULATION OF ARMOR PLATES.

The following is one of the processes for manipulating armor.

Stahl und Eisen publishes the following interesting description of the softening of armor plate by Dr. Hans Goldschmidt's "Aluminothermic" process, now being used abroad.

> The softening of armor plate in places has been successfully accomplished by means of the above-named process in the following manner:
>
> When it is desired to soften only a small spot for entering a bolt, a square 5 by 5 centimeters (2 by 2 inches) is laid off with bricks or preferably with a tin mold. This mold is held together by wire. The seams are carefully stopped up with molding sand. The mold itself should be about 10 centimeters (4 inches) high.
>
> When a large edge of a plate is to be softened at one time, the mold may be lower, so that a comparatively smaller quantity of the heating mass will be required. If the plate stands upright and it is desired to heat a vertical edge, the mold must, of course, be constructed accordingly. This does not offer any special difficulty, but care should be taken to construct the mold in a substantial manner and to support it well, so that no breaks may occur. Into this mold is poured, from a crucible of suitable size especially manufactured for this process, the heating substance designated

as thermite, heated to a temperature of 3,000° C. (6,782° F.). At the expiration of about half an hour the mold is removed and the thermite knocked off. It comes off easily and smoothly, without in the least injuring the plate. The particular part of the plate has by this time become sufficiently soft to enable a drill to enter it without breaking or being dulled.

It is not practicable to pour the thermite directly into the mold and then ignite it, because the metal formed by the reaction would in that case adhere to the plate. But if the liquid mass is poured from a crucible, as indicated, there forms between the armor plate and the metal separating from the thermite a very thin protective layer of aluminum-oxide (corundum), which renders it possible to remove the heating mass without any difficulty.

As compared with the method previously employed, the new process has the great advantage of being easy, safe, and quick. By this process it becomes possible to soften at the same time a whole edge of an armor plate, while with the oxyhydrogen blowpipe method each particular spot has to be softened gradually, and the source of heat must be applied many times, as the drill advances only a few millimeters at a time. With the Goldschmidt process the whole thickness of the hardened face can be softened simultaneously.

ALUMINUM THERMITE.

Engineering, of London, states that the composition is a mixture of powdered aluminum and iron oxide, kept in soldered boxes. The mixture is perfectly harmless, and molten iron can be poured into it without starting any reaction. If, however, a primer, consisting of powdered aluminum and some peroxide, is applied, the reduction commences at once. Welding is performed by this process also. To show the intense heat produced, a little of the ignition powder is dropped into a crucible and lighted with a common fuse. It flares up, and when thermite is gradually added the whole mass begins to boil. In a minute or less the fused alumina which floats on top may be poured off and then the molten iron made to follow. Pouring this into a bottomless crucible placed on a one-half inch iron plate, the reduced iron bores a hole quickly through the plate. The aluminum employed is the commercial aluminum of American and other works, of 98 per cent and more.

SECTION VI.

EXPLOSIVES.

In the past few years all the great powers have begun to abandon the nitroglycerine smokeless powders, on account of their destructive effect on the bores of modern rifles, and all are tending to some form of nitrocellulose powders.

At the present time the powders used by the several governments are as follows:

Germany uses the nitrocellulose in all guns except field-pieces and mortars.

France and Russia use nitrocellulose entirely.

England and Austria use cordite, and Italy and Norway use balistite.

There are two varieties of smokeless powder either nitroglycerine or nitrocellulose in some form or other.

(Some of the views contained in the following notes are from the lecture by Lieutenant Dawson, of Vickers, Sons & Maxim, delivered before the Society of Arts.)

The importance of this subject of smokeless powders can not be overestimated, the introduction of this powder having entirely altered the conditions of modern warfare, and it has done most to render obsolete artillery weapons useless and dangerous to the nation which does not keep pace with the developments of modern artillery enterprise.

The initiation of modern explosives has made it possible to more than double the energies of guns as compared with the days of black powder, bringing into the arena of practical warfare long range fighting by land and sea, such fighting being rendered accurate by the use of telescopic sights, range-finders, etc. It has also rendered a very great rate of fire possible owing to the smokelessness of the powder, the object fired at being practically visible at all times. Furthermore, there is practically no residue left in the gun. Therefore, as soon as one cartridge is fired another can be put in without the elaborate sponging, etc., required with the old powders. This also facilitates considerably a rapid rate of fire. These two advantages of higher energies and more rapid rate of fire are due to the introduction of smokeless powder. In field operations, even more than at sea, the strategical advantages of smokeless powder are obvious.

In the days of black powder the velocities were limited to about 1,600 foot-seconds, owing principally to the rapid rate of burning of the powder.

The modern propelling powders, such as the various forms of nitrocellulose and nitroglycerine, are much slower burning, and thus longer guns can be utilized, in which a greater number of expansions of the gas are obtained, thereby increasing the velocity to a very much greater extent.

There seems to be no difference of opinion at present as to the type of powder for use as a propellant, nitrocellulose being preferred by all powers. The nitroglycerine product has served its day, but owing to the great erosive effect of the guns a substitute had to be found. The generally accepted substitute is nitrocellulose. Nitrocellulose powder has the great advantage of being capable of producing in modern artillery the highest possible ballistic effect with the least amount of wear on the gun.

The heat produced is the principal factor in causing erosion—that is, erosion is proportional to the amount of heat developed—and it increases enormously in percentage upon a small comparative increase in the proportion of nitroglycerine.

What is desired in a smokeless powder is a large gas-volume factor with a low heat factor. An increase of the force by the addition of nitroglycerine unduly increases the heat factor at the expense of the gas factor.

A small quantity of nitroglycerine seems to be a good ingredient in powder with gun cotton, as it makes the powder work much better in the soft state and gives it better consistency in the dried state.

Nitroglycerine is also desirable in combination with low-grade gun cottons.

The temperature of the explosion of cordite is practically double that of nitrocellulose powders, which has a direct bearing upon the life of the gun, for with so high a temperature of explosion as cordite, far exceeding the melting point of steel, the gun can not last many rounds, especially if large charges are used developing heavy volumes of gas. Now, in order to obtain high ballistics, it is very necessary to develop very large quantities of gas, with the view of keeping the volumes of expansion of the gas at the higher pressures as long as possible and continuing these pressures to the muzzle of the gun. If cordite is used, having this very high temperature of explosion, these volumes of gas at the high pressure must of necessity seriously affect the bore of the gun, especially at the commencement of the rifling. The nature of the wear of the bore with cordite is also very serious, taking the form, as it does at the commencement of erosion, of very thin, fine lines, which develop as the rounds are continued, completely washing away the surface and quite abnormally enlarging the rear of the gun where the shot is rammed home. This, after a few rounds, allows the shot to be overrammed, increasing the volume of the chamber, which, in its turn, diminishes the pressure, reducing the energy of the gun and varying the velocities, and, therefore, the range accuracy, and, in fact, all the points which are absolutely essential to the gunner. Furthermore, the wear of the bore of the gun prevents the proper centering of the projectile at starting, causing it in many cases to gyrate when it comes under the influence of the rifling.

The use of nitroglycerine powders entails a loss of energy of about 34 per cent after about 200 rounds have been fired, owing to the development of erosive effects, so that no higher velocities than about 2,500 feet can be obtained for any reasonable number of rounds, whereas with nitrocellulose powders velocities up to and exceeding 3,000 feet can be easily obtained. As an example of the small erosion of guns when using a nitrocellulose powder, a Krupp 6-in. gun in which, after some 534 rounds had been fired, 76 of which were fired with prismatic powder and ballistite, the dimensions of the gun came within the accepted limits of a new gun. The velocities, however, in this test were not very high, being 2,300 foot-seconds.

The keeping quality of nitrocellulose is very good. Results of these powders which have been stored in the hottest climates show both ballistically and chemically the best results. Some of the German makers have had this powder under various heat tests for many years, and they say that nitrocellulose powders, if properly made, are to be relied upon not to deteriorate any more than cordite and other nitroglycerine products when subjected to variable climatic influences. Nitrocellulose gives higher ballistic effects than cordite at normal temperatures and enables increasing the range of initial velocities. The question of initial velocity is very important, as with this element increased comes greater energy, greater penetration of armor, and greater flatness of trajectory.

As stated in General Information Series, No. XIX, the British Government has appointed a committee of experts to examine and report upon a new explosive agent to replace cordite. This committee has as yet made no recommendation, but it is reported that they will adopt a pure nitrocellulose powder in cords for small arms and in tubes for artillery, probably of the Rottweil kind.

Cordite and its kindred smokeless powders proved to be an excellent article with the one exception of its high temperature of combustion, causing great erosion of the bores of guns. It is a really smokeless powder, is stable in all climates and temperatures.

The adoption of cordite as the accepted smokeless powder by the British Government was noted in General Information Series No. XV, when the process of manufacture was also described. This powder has been extensively used in Europe, and is admirable in many respects.

It is said to have such a high percentage of nitroglycerine, 58, as to be deleterious to the bores of guns; besides this it has 37 per cent of gun cotton, and 5 per cent of vaseline. This compound remains uniform in all climates, is safe, and can be depended upon for uniform results, and it is really smokeless. The large percentage of oxygen in nitroglycerine turns all the carbon into gas. Nitroglycerine is also a preservative. Most nitrocellulose powders consist of gun cotton, with or without an admixture of nitrates. These are gelatinized by means of a solvent and then cut up into cubes, etc. They are forms of gun cotton toned down by gelatinization. In Russia they use a nitrocellulose powder known as pyrocollodion, which seems to be giving satisfaction. This is a gun cotton manufactured in some special way.

Cordite is the product of gun cotton dissolved in nitroglycerine.

Gun cotton is also dissolved in acetic ether, alcoholic ether, or the like. Dissolving or gelatinizing gun cotton or soluble nitrocotton by the use of liquid solvents, such as acetic ether and acetone for the former and mixtures of ether and alcohol for the latter, by which process the fibrous character of the original substance is more or less destroyed and a horny material produced of a slower rate of combustion, the reduction being due to the change in physical condition.

The above product is rolled into sheets or pressed through suitable dies into wires, rods, or tubes, which are then cut up into suitable lengths for charges.

The German powder contained equal parts of nitroglycerine and gun cotton, but the percentage of nitroglycerine has been progressively reduced in order to lower the temperature of combustion of the powder. Up to quite recently the reduction was from 40 to 25 per cent of nitroglycerine, while cordite has 57 per cent. Lowering the temperature of combustion is sometimes effected by adding baryta saltpeter in small quantities to the nitroglycerine powder. This adds, however, a little smoke effect.

Other inventions have been brought out having for their object the lowering of this temperature of combustion of cordite and so reducing the erosion on the gun.

CASUALTIES.

In the latter part of April, just passed, a disastrous explosion occurred at the electro-chemical works near Griesheim, in the vicinity of Frankfort-on-the-Main, where smokeless powder is manufactured.

The factory and machinery were destroyed, and there was a large loss of life. The trouble is said to have originated in a small fire which ignited several receptacles of picric acid, exploding them, then exploding several large vats of chemicals, then spreading to the large quantity of barreled smokeless powder, blowing up them and the boilers. The fumes and masses of burning chemicals made it impossible for anyone to remain in the vicinity until the entire plant and buildings had been destroyed.

Several other more or less disastrous explosions have occurred during the past year, some of which have been traced to carelessness in manipulation, others to want of purity of the ingredients. Great care is used in the modern powder-making manufactories, in consequence of which accidents are fewer than in the past. Modern plants are so arranged that an explosion in one building will not affect other parts of the plant, and the number of persons likely to be involved in such an accident is made as small as possible.

In connection with the Griesheim explosion the *Berliner Lokal Anzeiger* comments as follows upon the dangers of the manufacture of picric acid:

THE DANGERS OF PICRIC ACID.

The terrible catastrophe which recently destroyed the Chemical Works Griesheim-Elektron, near Frankfort-on-the-Main, calls our attention to one of the most powerful explosives known, picric acid. * * * In its pure state picric acid appears in the shape of crystals—long, flat, shining needles, yellow in color and of extremely bitter taste. These crystals may be heated, apparently without danger, and melt at 122.5° Celsius (252.5° F.), that is, a little above the boiling point of water. With proper care the heating may be carried to an even higher point; but if the melted picric acid is heated suddenly it detonates. For a long time its manufacture was considered to be free from danger, as it was believed that, by using the necessary precaution, the dangerous elements lurking in this acid could be controlled. This was a fatal mistake, and had to be paid for with human lives. * * * Even by mixing picric acid with lead ocher, lead nitrate, strontium nitrate, etc., powerful detonations may be produced. When ignited, picric acid burns quite harmlessly, with a deep black flame producing much soot, without exploding. In burning it generates fumes which have that peculiar bitter taste noticed in the crystals, for which reason this acid, which has been known for over a hundred years, was formerly called Welter's bitters or indigo bitters. The effect is a very different one when it is ignited suddenly and by some powerful agent, as, for instance, in fuse devices for military purposes, or when those fine crystal needles, so harmless in appearance, are inclosed in vessels and then ignited. It then explodes almost exactly like gunpowder, except that the detonation is not so loud. In a compressed or melted state it exceeds in violence the most powerful explosives. Owing to its explosive power picric acid, when inclosed in projectiles, is one of the most effective substances for bursting shells; but at the same time it is dangerous for the men who have to handle the shell.

In 1886, Boulanger, the famous French general, asked the Parliament of his country for an appropriation of 50,000,000 francs for the introduction of a new and wonderful projectile of previously unattained destructive effect, which he called melinite shell. In order to win the Parliament for his plans, he invited the budget committee to a war game, at which firing trials were held with the new shell against Fort Malmaison, near Paris. The result was that the sum asked for was voted, and all the fortifications on the eastern boundary were equipped with the new projectiles. This melinite was nothing other than this same picric acid, which recently caused such destruction at Griesheim, except that it was mixed with gun cotton dissolved in ether. Some time later appeared the inventor, Turpin, who, sustained by the Paris press, claimed to have invented a bursting shell which, at a distance of several kilometers, could at one blow clear the field of the enemy. * * * Turpin demonstrated that pure picric acid, when in the melted state, is a more powerful explosive than the mixture known as melinite. In that state it is in fact far superior to the most powerful dynamite or gun-cotton preparation. It may, therefore, be assumed that the present melinite consists of melted picric acid alone, and is more or less identical with lyddite, manufactured for the English army at Lyd, England. Although melinite was at first enveloped in that veil of secrecy with which, for obvious reasons, anything new in the military arts is surrounded, other nations also—England and Germany, for instance—possess the secret of its manufacture. If I am not mistaken, Wille states that the melinite of the German army is known under the name of "Granatfüllung c/88″ (shell filling type, '88.)

Phenol, from which picric acid is won, is commonly known as carbolic acid, the well-known antiseptic and disinfectant.

The *Rivista di Artiglieria e Genio* publishes the following notes.

POWDERS USED BY DIFFERENT NATIONS.

It is at present the general opinion that each type of firearm requires a special powder in order to attain its object. Thus there are in existence many different kinds of powder, which, however, from the standpoint of their composition, may be restricted to a few classes.

Two kinds of smokeless powder are used:

(*a*) Nitrocellulose powder without nitroglycerine.

(*b*) Nitrocellulose powder with more or less nitroglycerine.

In order to distinguish these two kinds of powder more easily we will call the former gun-cotton powder and the latter nitroglycerine powder, the latter being a gun-cotton powder with an admixture of nitroglycerine. To the first group belongs also pyroxiline.

Nitroglycerine powder is used for small arms only in the following countries:

1. Italy, which uses ballistite and recently also solenite.
2. England, which uses the famous cordite.
3. Norway, which has adopted the Italian ballistite.

All other countries, with the exception of Greece and Portugal, which are still using black powder, use gun-cotton powder, mostly in the shape of flakes.

In the following table we enumerate the principal countries, their service powder, and the maximum gas pressure observed in their respective types of small arms. The pressures have been computed by taking the average of the results given by Maresch-Maudry (third edition), Wuich, Maudry (fourth edition), Dr. Guenther, and Bornequo.

Country and caliber.	Name of powder.	Shape.	Where manufactured.	Maximum gas pressure.	Initial velocity.	Muzzle energy.
Millimeters.				*Atmospheres.*	*Meters.*	*Metric kilograms.*
Germany, 7.9	Gun cotton	Flakes	Government factories and United Powder Factories, Köln-Rottweil.	3,200	640	312
Argentina, 7.65	do	do	Rottweil (Germany)	3,000	660–670	303.6
Belgium, 7.65	do	do	Wetteren (Belgium)	2,900	600	259
Denmark, 8	do	do	do	2,900	630	284.5
England, 7.7	Nitroglycerine.	Strands	Government and private factories.	2,800	610	264
France, 8	Gun cotton, B. F. (old)	Flakes		2,970	630	306

Country and caliber.	Name of powder.	Shape.	Where manufactured.	Maximum gas pressure.	Initial velocity.	Muzzle energy.
Millimeters.				*Atmospheres.*	*Meters.*	*Metric kilograms.*
Austria, 8	Gun cotton, M. 92.	Disks	Government and private factories.	3,000	620	310
Russia, 7.62	Gun cotton pyroxiline.	Flakes	Ochta and Scioska	2,900	635	281
Switzerland, 7.5	Gun cotton.	White cylinders.	Government factory, Worblaufen.	2,600	620	270.6
Turkey, 7.65	Gun cotton, M. 88/91.	Flakes	United Powder Factories, Köln-Rottweil.	3,000	652	299.3
United States, 7.62	Gun cotton, 91/93.	do		3,300	610	270.5
Brazil, 7	Gun cotton	do	Rottweil	3,000–3,300	710	287.9
Chile, 7	do	do	Troisdorf	3,400	710	287.9
Colombia, 7	Gun cotton, 91/93.	do	Rottweil	3,060	710	287.9
Mexico, 7	do	do	do	3,000–3,300	710	287.9
Servia, 7	do	do	do	3,000–3,300	710	287.9
Transvaal, 7	do	do	do	3,000–3,300	710	287.9
Uruguay, 7	Gun cotton	do	do	3,000–3,300	710	287.9
Italy, 6.5	Nitroglycerine, ballistite, solenite.	Grains	Avigliani and Fontana Liri.	4,000 about.	710	259.7
Holland, 6.5	Gun cotton	Flakes	Troisdorf	3,700	730	273.2
Norway, 6.5	Nitroglycerine, ballistite.	do	Norway	3,000	730	274.6
Roumania, 6.5	Gun cotton	do	Troisdorf and Government factories.	4,200	740	288.4
Sweden, 6.5	do	do	Troisdorf and home factories.	3,000	730	274.6
Spain, 7	Gun cotton, 91/93.	do	Rottweil	3,000–3,300	710	287.9

For guns, a list like the foregoing can not be given, because each country has a number of guns of different types.

In Germany, France, Russia, and the United States pure gun-cotton powder is used almost exclusively for the modern types of guns, with a few exceptions, as, for instance, for German howitzers and mortars.

In England, Italy, and Austria, on the other hand, only nitroglycerine powder is used for ordnance, although in England extensive experiments have been made with gun-cotton powder, which have given good results.

Brazil is about to build a factory for smokeless powder, and has invited competitors to submit results of tests made with pure gun cotton, and with gun cotton mixed with nitroglycerine (up to 20 per cent). It would therefore seem as though that country had not yet decided in favor of either kind of powder.

In Japan the tendency is at present to give preference to nitrocellulose.

Turkey purchased in March, 1900, 260,000 kilograms (573,200 pounds) of Rottweil smokeless powder. It appears that in future this country intends to manufacture its own powder. (Sultan's decree of August 20, 1900.)

Below we give the different kinds of powder used for the guns of the great powers of Europe.

1. AUSTRIA.

(1) 2 mm. (0.08 in.) powder M/93 for field, mountain, siege, and fortress guns	Nitroglycerine
(2) Powder in fine and coarse grains, prismatic powder, and powder in cubes for old type 31 and 28-mm. (1.22 and 1.1-in.) guns	Nitroglycerine

2. ENGLAND.

(1) Cordite, new, for all rapid-fire and breech-loading guns	Nitroglycerine
(2) Cordite, old	Nitroglycerine
(3) Schultze powder (being tested)	Nitrocellulose
(4) "B. E. C." powder (being tested)	Nitrocellulose

3. FRANCE.

(1) Powder in flakes for field, fortress, siege, coast, and naval guns.	
(2) Pyro-collodion powder	Nitrocellulose
(3) New "B. N." smokeless powder	Nitrocellulose
(4) Different kinds of powder, in grains, for guns of old type; also some kinds of brown, prismatic, and other powder for large naval guns.	

4. GERMANY.

(1) Gunpowder, 1896, for guns M/96.	
(2) Gunpowder in flakes for field pieces M/73 and 12-cm. (4.75-in.) guns	Nitrocellulose
(3) Powder in large flakes for 15-cm. (6-in.) long guns, 15 and 21-cm. (6 and 8.25-in.) built-up guns (Ringkanonen), and 21-cm. jacket guns (Mantelkanonen)	Nitrocellulose
(4) Powder in cubes for field howitzers and mortars	Nitroglycerine

5. ITALY.

(1) Ballistite for 4.2-cm. (1.65-in.) rapid-fire and all breech-loading guns	Nitroglycerine
(2) Swedish apirite, being tested for the purpose of superseding dynamite	Nitroglycerine
(3) Different kinds of black, brown, prismatic, and other powder from Government factories, and a few from Rottweil.	

6. RUSSIA.

(1) Pyro-collodion powder for 4.7-cm. (1.85-in.) rapid-fire guns, 30.4 cm. (12-in.) guns, and light field pieces (by way of experiment; resembles the French "B. N."). It is also used in the navy for 30.4, 25, 12, 7.5, and 4.7-cm. (12-in., 9.85-in., 4.75-in., 3.in., and 1.85-in.) guns	Nitrocellulose

SECTION VII.

TORPEDOES.

FRENCH EXPERIMENT.

A caisson representing a section of the immersed hull of the battleship *Henri IV*, whose compartments have been constructed with a view to resisting the explosion of automobile torpedoes, was moored in the Brest roadstead and firing trials were held against it. The *Yachting Gazette*, of Paris, publishes the following description of this trial:

> This caisson was built under the direction of the authorities of the dockyard where the above-mentioned battleship was building. The caisson carries the same armor, the same armored deck, the same coal chutes, compartments, and bulkheads as the type ship. Its length was 40.68 feet, height 39.96 feet, draught 24.93 feet, and displacement about 490 tons.
>
> The torpedo, represented by a war head 17.72 inches in diameter, carrying a charge of 220 pounds of gun cotton, was placed in contact with the caisson's side at a depth of 10 to 11 feet. In the rear of the charge was placed a compressed-air reservoir, containing air at 100 pounds pressure, the remaining pressure of a torpedo at the end of a normal run. The charge was fired from a near-by boat by an electric fuse, ignited by a battery. An enormous column of water was thrown up, the caisson sinking immediately. After great difficulty the caisson has been raised, and it was found that the torpedo had made a large hole, breaking through the double bottom.
>
> This experiment was particularly interesting, as, while it was known that torpedoes would produce enormous damage, up to the present time all experiments had taken place against old ships and hulks, and no practical tests had been made against modern constructions. It was to obtain this needed information, as well as to test the value of the form of construction of the under-water body of the *Henri IV*, that these trials were held.

RUSSIAN EXPERIMENTS.

On an uninhabited island in the Gulf of Finland a shed was built of zinced sheet iron, and in it was placed a torpedo-launching tube, with torpedo loaded and charged. The war head projected a little beyond the mouth of the tube.

The first experiment consisted in firing with rifles at the air chamber of the torpedo, which was filled with compressed air at 80 atmospheres. A bullet struck the air chamber and passed through its wall, the air escaping without any explosion. Outside of the hole in the chamber, no damage was done.

The next experiment consisted in exploding a gun-cotton charge of 187 pounds in the shed near the projecting war head of the torpedo.

In order to observe the effect also upon living beings, a number of sheep were made to share in the experiment. Twenty minutes after all observers had withdrawn to a neighboring island, the gun-cotton exploded, causing the war head also to explode. The shed, the launching tube, the torpedo in it, and the sheep grazing in the vicinity, were blown to pieces, while one animal, which had strayed about 90 feet away, remained unharmed. The officers on the neighboring island experienced only a violent air shock. The destructive effect of the explosion was confined to a comparatively small area.

Following this, an under-water experiment was made on a barge, the bottom of which was protected with 4-inch steel plates. A torpedo boat launched a torpedo against the bottom of the barge, the latter being shattered into atoms by the explosion.

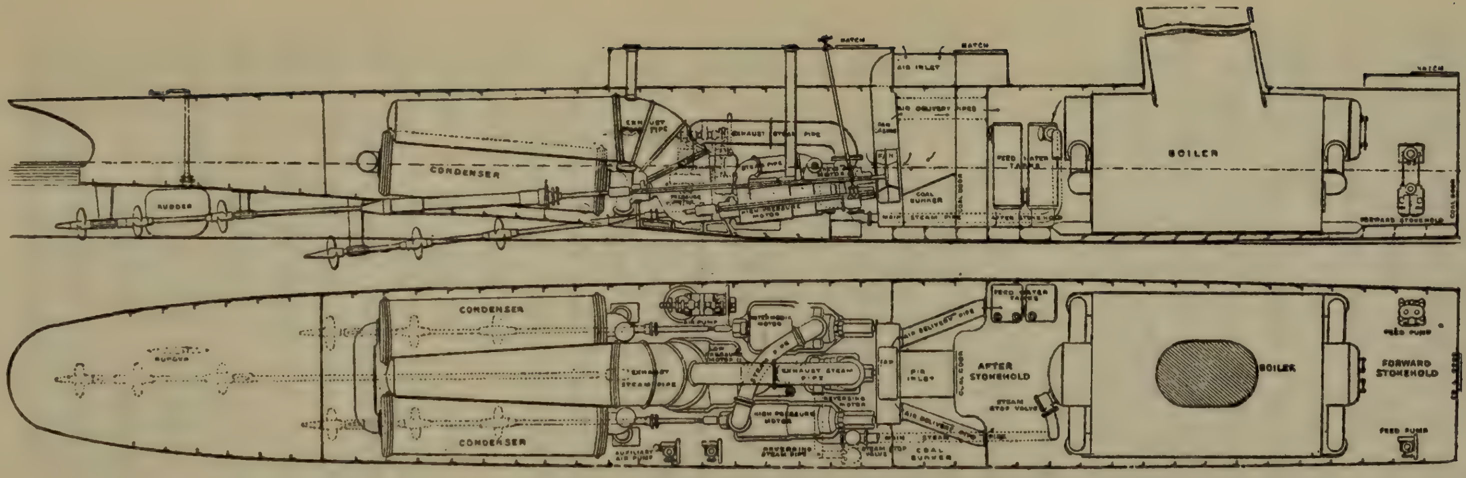
THE WIRELESS DIRIGIBLE TORPEDO.

There are several applications of this principle abroad and one at home. The system has been under experiment for many years, but has only recently been applied, and is still in the experimental stage.

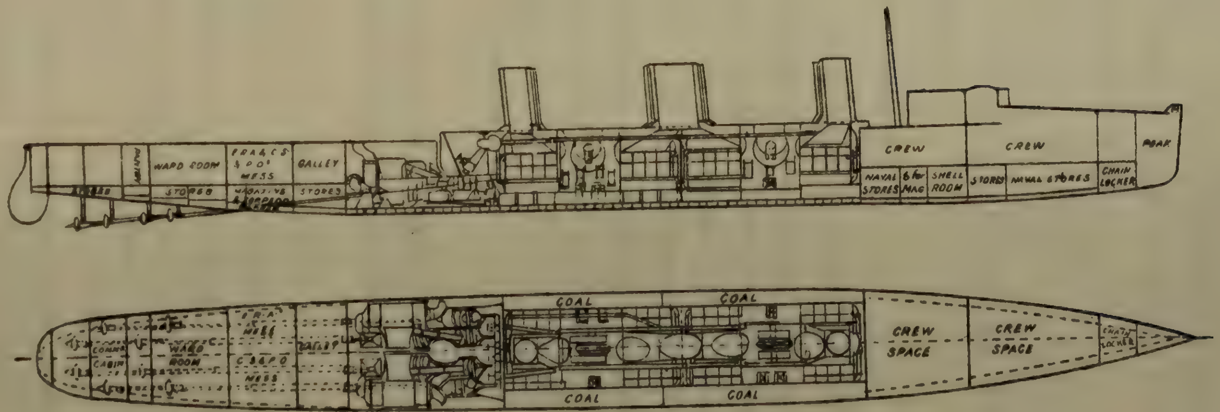
It is said that a torpedo of this type was tried at Stockholm, December, 1898, in the presence of King Oscar. It is also reported in the press that runs were held with the same torpedo last year at Langstone Harbor, near Portsmouth, over distances of 2½ to 3 miles, and that these demonstrations showed that ranges of 15 to 20 miles seemed ultimately to be perfectly attainable, the sending station to be on shore or on shipboard.

The English and American press have recently published notes on the following controllable torpedo, from which publications the following are extracts:

This system was invented some time ago by a Mr. Cecil Varicas, an English electrician. The system is yet in the experimental stage. The trials have been successful in directing and controlling models of launches and torpedoes. The apparatus is said to cost but a third of that of the Whitehead. The present range of the system is 200 yards, but this will no doubt be greatly increased by improvements in the instruments. The inventor employs the Marconi system, and recently a test was made in the open sea in the English Channel in which the inventor was able to manipulate by means of ether waves, and with great success, the movements of his torpedo in any desired direction while it was traveling below the surface.



ARRANGEMENT OF MACHINERY IN TURBINIA.



Arrangement of Machinery in H. M. Torpedo-boat Destrover Viper.

III.

ENGINEERING NOTES.

By Lieutenant L. R. de Steiguer, United States Navy,
Staff Intelligence Officer.

SECTION I.

GENERAL NOTES.

Since the last annual of this office there has been little of interest to report upon new designs of machinery. The submarine has been attracting the attention of foreign governments, and boats of this type have been ordered for the navies of England, France, and Sweden. The trials of the *Viper* and *Cobra*, turbine destroyers, have been continued in England. The *Viper*, at a displacement of 370 tons, obtained 36.581 knots on a one-hour's full-power trial, with a maximum speed of 37.113 knots. The revolutions were 1,180 per minute and the air pressure 4½ inches. The speed of 37.113 knots represents about 12,300 I. H. P., as compared to the 6,000 or 7,000 H. P. in the ordinary destroyer. This boat has carried out all of her official trials successfully, making the guaranteed speed astern of 15½ knots, exceeding the 31 knots required by over 5 knots, and only consuming 2.38 pounds of coal per I. H. P., being allowed 2.5 pounds per I. H. P. per hour at 31 knots speed. The high speeds made by the *Cobra* and *Viper*, the first two boats of this type, have been obtained with practically complete absence of vibration from main engines, which is so excessive in torpedo vessels, and without accidents in the engine room, which are of so common occurrence with the reciprocating engines of this class.

Increased speed, efficiency in coal consumption near designed speeds, absence of vibration from main engines, increased stability, increased safety to engine-room force owing to absence of reciprocating parts, perfect balancing of engines, reduced weights and cost of attendance, smaller diameter of propellers reducing racing in a sea way and facilitating navigation in shallow waters, are the principal advantages claimed for the turbine, and they may cause its use in torpedo boats and fast merchant vessels; but the increased coal consumption at low speeds will probably prevent its use in large vessels of war, where the ordinary cruising is done at about one-half the full speed.

LIQUID FUEL.

Foreign governments continue to use and experiment with liquid fuel to about the same extent as was reported in the last annual.

According to the press the British Admiralty intend to renew their experiments with oil fuel on board the destroyer *Surly.* Borneo oil will be used, however, as the experiments last year with American petroleum were unsatisfactory, owing to the thick black smoke produced.

Interesting trials have been made on the torpedo boat *Ophir*, built by Yarrow & Co. for Holland, with the object of testing Holden's system of burning oil. A trial was first made with coal, when a speed of 24½ knots was obtained. When the oil burners were started, using the oil and coal together, the speed was increased 2 knots—i. e., to 26½ knots. The consumption of coal was 2,800 pounds per hour, and when Borneo oil was introduced, 700 pounds of this fuel in addition. When burning oil in one boiler—half-boiler power—a speed of 14 knots was obtained with 500 pounds of oil per hour.

The French battleship *Jéna* has completed very satisfactory trials with liquid fuel. When oil and coal were used in mixed combustion the engines passed from 4,000 to 6,500 H. P. in a very few minutes.

In April the battleship *Kaiser Freidrich III* ran upon a rock and bulged in the outer plates, in the wake of the "mazut" oil carried in the double bottoms. The oil was forced out through the air-relief pipe and flowed down into the fire room, where it caught fire and caused considerable damage. These compartments were flooded and the flames were smothered under the protective deck.

The following article, from one of the foreign-service magazines, gives the service performed by the steamship *Cowrie*, of the Shell Transport and Trading Company. The liquid-fuel apparatus for two of the steamers of this company was described in the last annual:

LIQUID FUEL IN STEAMERS.

The steamship *Cowrie*, of the Shell Transport and Trading Company, lately steamed all the way from Koetei, in Borneo, to London—9,250 miles—using nothing but liquid fuel, and the boilers supplying the steam for the pumps that are now discharging the cargo are fired by the same material. The oil is not burnt by the aid of a thin layer of incandescent coal as is the case in some systems, but is pulverized or reduced to spray by means of a steam jet at the furnace door, where it is delivered from service tanks above the boilers. The *Cowrie* was formerly fired with coal, and her conversion to liquid fuel has been attempted with advantageous results. Her complement of stokers has been reduced to 6, as against 16 necessary with coal, and her speed has, at the same time, been slightly improved. Moreover, the change has effected an important saving in bunker space, for her consumption of oil on this voyage was only 22 tons a day, whereas her daily consumption of coal used to be 35 tons, and a ton of oil is calculated to occupy only 34 cubic feet, against 45 feet required for coal. Oil, too, can be carried in the water-ballast tanks, and can also be taken on board much more quickly than coal—on a recent occasion 300 tons were pumped into a German steamer in one hour. The oil yielded by the Borneo fields forms an excellent fuel when used just as it comes from the ground, and it is said to be superseding both the Russian and American products in the Far East, where it is extensively used for fuel in steamers—e. g., the Hamburg-American boats engaged in the Eastern trade. To give some idea of its cost, it may be mentioned that, according to the terms of a recent contract, which need not be specified exactly, it is to be delivered at the price of 30s. a ton at Singapore and Hong Kong, 32s. 6d. at Shanghai, 35s. in Japan and Colombo, and 50s. at Suez. The *Cowrie* brought from Borneo over 6,000 tons of solar oil, the greater part of which is destined to be used by the Gas Light and Coke Company for the production of oil gas for enrichment purposes, and it is an interesting fact that the vessel (or one like her) will be bunkered with the refuse that remains after the oil has been utilized in this manner.

SECTION II.

BOILERS.

Since the memorandum on water-tube boilers was issued, the Admiralty has appointed a boiler committee to investigate and report upon the advantages and disadvantages of the Belleville boiler for naval purposes as compared with the cylindrical boiler; to investigate the causes of the defects which have occurred in ships fitted with them, and to report how far they are preventable; to report on the advantages and disadvantages of the Niclausse, Babcock & Wilcox, or any other discription of boiler, as compared with the Belleville.

In addition to attending the trials of vessels fitted with water-tube boilers and to conducting experiments between vessels having installations of the cylindrical and Belleville boilers, the committee has taken evidence from the engineer officers; has sent several of its members to inspect the Belleville boilers on board the vessels of the Messageries Maritimes Company, and has visited the principal boiler works in England, the Niclausse works in France, and the Dürr works in Germany.

It was officially stated in the House of Commons that £160,000 had been expended in royalties upon the Belleville boilers of twenty-six ships in commission, and of forty now under construction which have been designed for this type of boiler.

In January the committee was called upon for an interim report upon the following questions:

Whether water-tube boilers are considered by the committee to be more suitable than cylindrical boilers for naval purposes; and if so, if the Belleville had such an advantage over other types of water-tube boilers as to lead the committee to recommend it as that best adapted for the navy. Whether the committee were prepared to recommend or offer any suggestions on the extent to which any particular type of boilers should be fitted in new vessels.

The committee reported in general that the advantages of water-tube boilers are so great, chiefly from the military point of view, that, provided a satisfactory type be adopted, it will be more suitable for use in the navy than the cylindrical type of boiler; that the committee did not consider that the Belleville had any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of the navy. The committee also recommended:

As regards ships which are to be ordered in the future: That Belleville boilers be not fitted in any case.

As regards ships recently ordered for which the work done on the boilers is not too far advanced: That Belleville boilers be not fitted.

As regards ships under construction for which the work is so far advanced that any alteration of type of boiler would delay the completion of the ships: That Belleville boilers be retained.

As regards completed ships: That Belleville boilers be retained as fitted.

The committee also urged the trial in ships of four types of large, straight-tube boilers—Babcock & Wilcox, Niclausse, Dürr, and the Yarrow large-tube boiler.

The naval engineer member of the committee made a minority report concurring with the report except that he thought that the Belleville boiler was a good steam generator which would give satisfactory results when it was kept in good order and worked with the required care and skill. At the same time he did not think that the progress of ships should be delayed in order to substitute another type of boiler.

Steps have already been taken to carry out the recommendations of the boiler committee. The work in connection with the Belleville boilers of seven ships has been suspended, but in the case of one ship, the *Lancaster*, the work has been ordered to be resumed, it having been found on inquiry that a change in the type of boiler at the present stage would involve great delay in the completion of this ship.

The instructions to the committee, their report, and a translation of the letters written by Mr. Belleville in answer to the criticisms contained in the report are published below in full.

Descriptions and cuts of the Belleville and the four types recommended by the committee—Babcock & Wilcox, Niclausse, Dürr, and Yarrow—are appended for reference.

WATER-TUBE BOILERS, &C.

[Copy of a letter of instructions sent to the president.]

ADMIRALTY, S. W., *6th September, 1900.*

SIR: I am commanded by my Lords Commissioners of the Admiralty to inform you that they are pleased to nominate you as chairman of a committee which they have decided to appoint for the purpose of considering certain questions arising in connection with the use of various modern types of boilers for naval purposes, as set forth in the terms of reference specified in the succeeding paragraphs of this letter.

(2) In addition to yourself, the committee will be composed of the following members:

Mr. J. A. Smith (inspector of machinery, R. N.).
Mr. John List, R. N. R. (superintending engineer, Castle Line).
Mr. James Bain, R. N. R. (superintending engineer, Cunard Line).
Mr. J. T. Milton (chief engineer-surveyor of Lloyd's Register of Shipping).
Professor A. B. W. Kennedy.

Mr. J. Inglis, LL. D. (head of the firm of Messrs. A. & J. Inglis, engineers and shipbuilders, Pointhouse, Glasgow).

Commander Montague E. Browning, R. N., and Chief Engineer William H. Wood, R. N., will act as joint secretaries to the committee.

(3) The points which it is desired that the committee should investigate and report upon are as follows:

(*a*) To ascertain practically and experimentally the relative advantages and disadvantages of the Belleville boiler for naval purposes as compared with the cylindrical boiler.

(*b*) To investigate the causes of the defects which have occurred in these boilers and in the machinery of ships fitted with them, and to report how far they are preventable either by modifications of details or by difference of treatment, and how far they are inherent in the system. The committee should also report generally on the suitability of the propelling and auxiliary machinery fitted in recent war vessels and offer any suggestions for improvement, the effect as regards weight and space of any alterations proposed being stated.

(*c*) To report on the advantages and disadvantages of the Niclausse and Babcock & Wilcox boilers compared with the Belleville as far as the means at the disposal of the committee permit, and also to report whether any other description of boiler has sufficient advantages over the Belleville or the other two types above mentioned as a boiler for large cruisers and battleships to make it advisable to fit it in any of Her Majesty's ships for trial.

(4) For the purpose of making direct experiments between ships fitted with Belleville and cylindrical boilers, respectively, the *Hyacinth*, fitted with Belleville boilers, will be placed at the disposal of the committee as soon as the crew have been sufficiently trained and such trials have been carried out as to ensure that the machinery is in efficient order. A cruiser of similar type fitted with cylindrical boilers will also be placed at the disposal of the committee when required for the purposes of comparison.

(5) For the investigation of defects, copies of the reports of all the defects of machinery and boilers which occurred during the recent naval manœuvres will be placed before the committee, and they will be able to inspect ships specially commissioned for the manœuvres, which include the *Ariadne* and *Gladiator* with Belleville boilers, and the *Perseus* and *Prometheus* with Thornycroft boilers, with any others that may have returned to any of the home ports.

(6) The *Europa* is now on passage from Australia, and it is desired that, at a suitable time, an investigation into the causes of her high coal expenditure and machinery defects shall be conducted under the directions of the committee, and that she shall afterwards be put through such trials as the committee think necessary.

(7) Information on any special points connected with the behaviour of the boilers or machinery of water-tube boiler ships on ordinary peace service which the committee may desire to have will be obtained by the Admiralty from any of Her Majesty's ships in commission, and opportunities can be taken when the Channel Squadron is in any of the home ports to examine the boilers and machinery of the *Niobe*, *Diadem*, *Arrogant*, and *Furious*, which have Belleville boilers, and the *Pactolus*, which is fitted with Blechynden boilers.

(8) The *Pelorus*, fitted with Normand boilers, which has recently returned from three years' continuous service in the Channel Squadron and at the Cape of Good Hope, and the *Powerful* will also be available for examination during their refits.

(9) The *Sharpshooter*, fitted with Belleville boilers without economizers, the *Seagull*, fitted with Niclausse, and the *Sheldrake*, with Babcock & Wilcox boilers, will be employed in training stokers and will be available for examination and, if necessary, for any comparative experiments between these boilers that the committee may wish to make, though the comparatively low pressure for which the machinery

of these vessels was designed makes it impossible to try these boilers under the conditions under which they would work if fitted in a new ship.

(10) It is particularly desired that any conclusions the committee may arrive at should be supported by experimental proof as far as possible, and that the committee should propose any further experiments they think necessary for this purpose.

I am, sir, your obedient servant,

EVAN MACGREGOR, *Secretary.*

Vice-Admiral Sir COMPTON DOMVILE, K. C. B.

[Copy of letter asking for an interim report.]

ADMIRALTY, S. W., *4th January, 1901.*

SIR: I am commanded by my lords commissioners of the Admiralty to inform you that they will be glad to have an interim report from the boiler committee, as soon as possible, on any of the points referred to the committee on which they consider they have collected sufficient evidence or experimental proof to enable them to form a reliable opinion.

The questions to which my lords especially desire an answer are the following:

(1) With the experience and information which have already been obtained, can it be stated whether water-tube boilers are considered by the committee to be more suitable than cylindrical boilers for naval purposes?

(2) Should the answer to the above question be in the affirmative, do the committee consider that the Belleville boiler has such an advantage over other types of water-tube boilers as to lead them to recommend it as that best adapted to the requirement of H. M. navy?

(3) Generally, having regard to the importance of deciding on the types of boilers to be provided for vessels which are ordered in the immediate future, are the committee prepared at present to make any recommendation, or to offer any suggestions on the extent to which any particular type or types of boilers should be fitted in new vessels?

Whilst their lordships are anxious to receive an interim report at as early a date as practicable, they in no way wish to press the committee for a premature expression of opinion.

I may add that any report made should be accompanied by full particulars of all the evidence and experimental data on which the recommendations of the committee are based.

I am, sir, your obedient servant,

EVAN MACGREGOR.

The SECRETARY, BOILER COMMITTEE.

ADMIRALTY, *19th February, 1901.*

BOILER COMMITTEE.

SIR: I have now the honor to submit for their lordships' information the *ad interim* report called for by their letter S. 315/407 of the 4th January, 1901, on the three questions to which the attention of the committee was especially directed, viz:

"(1) With the experience and information which have already been obtained, can it be stated whether water-tube boilers are considered by the committee to be more suitable than cylindrical boilers for naval purposes?

"(2) Should the answer to the above question be in the affirmative, do the committee consider that the Belleville boiler has such an advantage over other types of water-tube boilers as to lead them to recommend it as that best adapted to the requirement of H. M. navy?

"(3) Generally, having regard to the importance of deciding on the types of boilers to be provided for vessels which are ordered in the immediate future, are the committee prepared at present to make any recommendations or to offer any suggestions on the extent to which any particular type or types of boilers should be fitted in new vessels?"

The replies to these questions are given in the first three paragraphs of the report, and the reasons for the replies in the remaining paragraphs, with all the advice the committee are at present able to give on the subject of the future boiler for the navy, with suggestions for trying two new types of boilers as quickly as possible.

The report is unanimous with the exception of Mr. J. A. Smith, inspector of machinery, who, though agreeing with the tenor of the report as a whole, explains that, in his opinion, the Belleville boiler will give satisfactory results when carefully treated, and considers there is no necessity for delaying the progress of ships already designed for them.

In conclusion, I should like to bring to their lordships' notice the great zeal and trouble taken by the civilian members of this committee to attend the meetings and trials necessary to form an opinion on this question, often at great inconvenience to themselves, being all busy men with their own special work to do.

I have the honor to be, sir, your obedient servant,

COMPTON DOMVILE,
Vice-Admiral, President Boiler Committee.

The SECRETARY OF THE ADMIRALTY.

AD INTERIM REPORT.

(1) The committee are of opinion that the advantages of water-tube boilers for naval purposes are so great, chiefly from the military point of view, that, provided a satisfactory type of water-tube boiler be adopted, it would be more suitable for use in His Majesty's navy than the cylindrical type of boiler.

(2) The committee do not consider that the Belleville boiler has any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of His Majesty's navy.

(3) The committee recommend:

(*a*) As regards ships which are to be ordered in the future, that Belleville boilers be not fitted in any case.

(*b*) As regards ships recently ordered, for which the work done on the boilers is not too far advanced: That Belleville boilers be not fitted.

(*c*) As regards ships under construction, for which the work is so far advanced that any alteration of type of boiler would delay the completion of the ships: That Belleville boilers be retained.

(*d*) As regards completed ships: That Belleville boilers be retained as fitted.

(4) In addition to the Belleville type of boiler, the committee have had under consideration four types of large straight tube boilers which have been tried in war vessels, and are now being adopted on an extended scale in foreign navies. These are:

(*a*) The Babcock & Wilcox boiler.
(*b*) The Niclausse boiler.
(*c*) The Dürr boiler.
(*d*) The Yarrow large-tube boiler.

(*a*) and (*b*) have also been tried in our own navy with satisfactory results, and are now being adopted on a limited scale.

If a type of water-tube boiler has to be decided on at once for use in the navy, the committee suggest that some or all of these types be taken.

(5) The committee recommend that the completion of the two sloops and the second-class cruiser fitting with Babcock & Wilcox boilers, and the sloop and first-class cruiser fitting with Niclausse boilers, be expedited, in order that the value of these types of boilers for naval purposes may be ascertained at the earliest possible date. This is especially important, as the Babcock & Wilcox boiler adopted in the ships under construction differs materially from the Babcock & Wilcox boiler as fitted in the *Sheldrake.*

(6) The committee recommend that boilers of the Dürr and of a modified Yarrow type be made and tested at the earliest possible date, under their supervision, with a view of aiding the selection of one or more types of water-tube boilers for use in His Majesty's ships. For this purpose the committee suggest that two cruisers, not smaller than the *Medea* class, with vertical triple-expansion engines, be placed at their disposal, and that they be empowered to order at once Dürr and Yarrow boilers to be fitted to them, and to order also the removal of their present boilers and the necessary modifications to their machinery, so that the performance of the types of boilers named may be definitely ascertained under ordinary working conditions from extended seagoing trials. The committee suggest vessels not smaller than the *Medea* class, because the evidence before them shows that it has been difficult to draw from torpedo gunboat trials conclusions fully applicable to larger vessels.

(7) With reference to paragraph (1), evidence has been given before the committee to the effect that three most important requirements, from the military point of view, are:

(*a*) Rapidity of raising steam and of increasing the number of boilers at work.

(*b*) Reduction to a minimum of danger to the ship from damage to boilers from shot or shell.

(*c*) Possibility of removing damaged boilers and replacing them by new boilers in a very short time and without opening up the decks or removing fixtures of the hull.

These requirements are met by the water-tube boiler in a greater degree than by the cylindrical boiler, and are considered by the committee of such importance as to outweigh the advantages of the latter type in economy of fuel and cost of upkeep.

(8) The opinion expressed by the committee in paragraph (2) has been formed after a personal examination of the boilers in a number of His Majesty's ships, including the *Diadem*, *Niobe*, *Europa*, *Hermes*, *Powerful*, *Furious*, and *Ariadne*, upon the statements of defects which have been placed before them, and the evidence of the chief engineers of those vessels and other officers on the engineering staff of the admiralty and dockyards. This evidence is being printed and will be forwarded when ready.

(9) The committee consider the following points in relation to the construction and working of the Belleville boiler to constitute practical objections of a serious nature:

(*a*) The circulation of water is defective and uncertain, because of the resistance offered by the great length of tube between the feed and steam collectors, the friction of the junction boxes, and the small holes in the nipples between the feed collector and the generator tubes, which also are liable to be obstructed and may thus become a source of danger.

(*b*) The necessity of an automatic feeding apparatus of a delicate and complicated kind.

(*c*) The great excess of the pressure required in the feed pipes and pumps over the boiler pressure.

(*d*) The considerable necessary excess of boiler pressure over the working pressure at the engines.

(*e*) The water gauges not indicating with certainty the amount of water in the boiler. This has led to serious accidents.

(*f*) The quantity of water which the boiler contains at different rates of combustion varying, although the same level may be shown on the water gauges.

(*g*) The necessity of providing separators with automatic blow-out valves on the main steam pipes to provide for water thrown out of the boilers when speed is suddenly increased.

(*h*) The constant trouble and loss of water resulting from the nickel sleeve joints connecting the elements to the feed collectors.

(*i*) The liability of the upper generator tubes to fail by pitting or corrosion, and, in economiser boilers, the still greater liability of the economiser tubes to fail from the same cause:

Further—

(*k*) The upkeep of the Belleville boiler has so far proved to be more costly than that of cylindrical boilers; in the opinion of the committee this excess is likely to increase materially with the age of the boilers.

(*l*) The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service, as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and, in considering the radius of action, it is doubtful whether any real advantage has been gained. The committee are not prepared without further experience to say to what extent this may not apply to other types of water-tube boilers.

(10) At the time the Belleville boiler was introduced into the navy in the *Powerful* and *Terrible*, it was the only large-tube type of water-tube boiler which had been tried at sea on a considerable scale under ordinary working conditions. The committee therefore consider that there was justification for then regarding it as the most suitable type of water-tube boiler for the navy.

(11) To obtain satisfactory results in the working of the Belleville boiler, in face of the defects named in paragraph (9), more than ordinary experience and skill are required on the part of the engine-room staff. It appears, however, from the evidence placed before the committee, that the engineer officers in charge of Belleville boilers have not been made acquainted with the best method of working the boilers and that which experience has shown to be most effectual in preventing the pitting and corrosion of tubes.

(12) In view of the rapid deterioration of economiser tubes in several vessels, the committee have specially considered whether the extra power per ton of boiler at high rates of combustion obtained by the use of economisers has not been too dearly purchased. The evidence before them indicates that at the lower and more usual rates of combustion the *Powerful* type of boiler has given results as satisfactory as the economiser type. It is at the same time less complex and free from the special risks of tube deterioration which have proved so serious in many cases, notably in the *Europa*. They therefore recommend for ships under construction that the non-economiser type should be reverted to where practicable, with the tubes raised higher above the fire bars to increase the combustion space, and that where possible the steam collectors should be made larger and more accessible internally.

(13) The evidence before the committee shows that a large proportion of the coal expended in the navy is used for distilling and other auxiliary purposes, in harbour as well as at sea. For such purposes the cylindrical boiler is, in the opinion of the committee, more suitable and economical than any type of water-tube boiler. They recognise that there are objections to fitting cylindrical and water-tube boilers in combination, but they believe that those drawbacks would be more than compensated for by resulting advantages, observing that the cylindrical boilers could be used for supplying distilled water in case of failure or insufficiency of the evaporating plant. On these grounds it is considered desirable that all the new vessels of large power should be provided with cylindrical boilers to do the auxiliary work.

(14) The committee have to state, for the information of their lordships, that a

series of comparative trials for determining economy in coal and water consumption were arranged in October, 1900, for His Majesty's ships *Minerva* and *Hyacinth*. The trials of the former ship commenced on January 7th, as soon as she was ready, but were temporarily interrupted by recent events. The committee are, however, now informed that the *Minerva* will not be again available until after March 2nd, and that the *Hyacinth* will not be ready to commence her trials until the first week in April. It is proposed to include in these trials a full-speed run for both ships from Portsmouth to Gibraltar and back.

COMPTON DOMVILE,
Vice-Admiral and Chairman.
JAS. BAIN.
JOHN INGLIS.
ALEX. B. W. KENNEDY.
JOHN LIST.
J. T. MILTON

M. E. BROWNING,
WM. H. WOOD,
Joint Secretaries.

I concur with the above report, except as regards paragraph 3, and on the point dealt with in that paragraph my report is as follows:

(1) Although the Belleville boiler has certain undesirable features, I am satisfied, from considerable personal experience, and from the evidence of engineer officers who have had charge of boilers of this type in commissioned ships, that it is a good steam generator, which will give satisfactory results when it is kept in good order and worked with the required care and skill.

I am also satisfied, from my inspection of the boilers of the Messageries Maritimes Company's S. S. *Laos*, after the vessel had been employed on regular mail service between Marseille and Yokohama for more than three years without having been once laid up for repairs, that, with proper precaution, the excessive corrosive decay of the tubes which has occurred in some instances can be effectually guarded against.

(2) Having in view the extent to which Belleville boilers have already been adopted for His Majesty's ships, and the fact that there are now three or four other types of water-tube boilers which promise at least equally good results, I am of opinion that, pending the issue of the final report of the committee, Belleville boilers should not be included in future designs. At the same time, I see no necessity for delaying the progress of ships which have been designed for Belleville boilers in order to substitute another type of boiler.

JOS. A. SMITH.

Engineering gives the following account of the comparative trials carried out by the *Minerva* and *Hyacinth*, referred to in the above report, for the information of the boiler committee:

Trials of the Minerva and Hyacinth.—The comparative trials of the cruisers *Hyacinth*, Capt. R. K. McAlpine, and *Minerva*, Capt. C. H. Cochran, which have lasted for several weeks, and which were ordered for the information of the boiler committee, concluded on the 25th instant, but next week the vessels will leave on a coal-endurance trial to Gibraltar, and on a speed contest home, with the members of the committee on board. The *Minerva* has eight cylindrical boilers with 19,200 square feet of heating surface, and the *Hyacinth* has eighteen Belleville boilers with 17,000 square feet of boiler heating-surface and 7,000 square feet of economiser heating-surface, making a total of 24,000 square feet, against 19,200 square feet in the *Minerva*. The steam pressure in the boilers of the *Minerva* is 150 pounds to the square inch, against 300 pounds in the *Hyacinth*, and the steam pressure at the engines is 150 pounds and

250 pounds respectively. The weight of boilers, with water, in the *Minerva* is 340 tons, and the weight, under the same conditions, in the *Hyacinth* is 280 tons. The maximum indicated horsepower for an eight hours' run in the *Hyacinth* is 10,000 and in the *Minerva* 8,000. Both ships are sheathed and are of the same displacement. The *Minerva* carried out her trials first, and on a twenty-four hours' run at 2,000 indicated horsepower she burned 2.2 pounds of coal per unit of power per hour for all purposes; while on a corresponding trial the *Hyacinth* consumed 2 pounds. The evaporation of water per pound of coal in the *Hyacinth* was 9.7 pounds and in the *Minerva* 8.7 pounds. The speed of each ship was 12 knots. At the twenty-four hours' trial at 5,000 indicated horsepower the coal consumption in the *Minerva* was 1.74 pounds per unit of power per hour, and in the *Hyacinth* 1.84 pounds; and while the evaporation of water per pound of coal in the *Minerva* was 8.9 pounds, in the *Hyacinth* it was 9.5 pounds. Here, again, both ships gave the same speed—16 knots. On her eight hours' trial at full power, or 8,000 indicated horsepower, the *Minerva's* coal consumption was 2.4 pounds per indicated horsepower per hour, while on an eight hours' trial at 10,000 indicated horsepower the coal consumption of the *Hyacinth* was 2.1 pounds, the speeds being, respectively, 18 and 20 knots. The water evaporated per pound of coal in the *Minerva* was 8.1 pounds, and in the *Hyacinth* 8.8 pounds. Here, according to the original programme, the trial ended, but the *Hyacinth* had not done a run at 8,000 indicated horsepower, and yesterday's trial at that power was necessary to complete the series. The coal consumption was 1.8 pounds per unit of power per hour, and the water evaporated per pound of coal was 10 pounds. The speed recorded by the patent log was 18½ knots. At each run boilers, machinery, and engine-room staffs worked smoothly, and gave no trouble of any kind. So far as the trials have gone, they have shown a superior economy in the Belleville boilers of the *Hyacinth*, and each pound of coal burned in the *Hyacinth* evaporated more water than the same quantity burned in the *Minerva*. The *Hyacinth* showed an advantage in speed.

LETTERS FROM MR. BELLEVILLE, IN ANSWER TO THE CRITICISMS IN THE INTERIM REPORT OF THE BOILER COMMITTEE.

[Translation.]

To the SECRETARY OF THE ADMIRALTY:

SIR: Since answering on the 13th of March the questions you asked me, I have become acquainted with the *interim* report of the Water-Tube Boiler Committee, published in the number of the *Times* corresponding to the same date, March 13.

I think it necessary to place before the Admiralty the following remarks, which occurred to me while reading that document:

After declaring in paragraph 1 that the advantages of water-tube boilers for naval purposes are so great, chiefly from the military point of view, that their use is more suitable for the navy than cylindrical boilers, the committee states, paragraph 10, that at the time the Belleville boiler was introduced into the navy, in the *Powerful* and *Terrible*, it was the only large-tube type of water-tube boiler which had been tried at sea on a considerable scale under ordinary working conditions, and that they would, therefore, be justly considered as the best system of water-tube boilers for the fleet. At present, on the contrary, the committee express the opinion, in paragraph 2 of its report, that the Belleville boiler does not possess any such advantages over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of His Majesty's navy. It even suggests, in paragraph 4, that a preference should be given to the other four types of boilers. This new opinion could only be justified if, since its installation on board the *Powerful* and *Terrible*, the Belleville boiler had ceased to be used at sea upon a considerable scale under ordinary working conditions, and if from that time the Admiralty had had an opportunity to experiment with other types of water-tube boilers to such an extent as to permit expressing a qualified decision.

The fact is, as far as the Belleville boiler is concerned, that since its installation on board the *Powerful* and *Terrible*, its use has been extended to all the navies in the world, and has given everywhere the same good results.

In regard to the four types recommended by the committee, to what extent have they been tried by the British Admiralty?

Two of these types, designated by letters (*a*) and (*b*), have only been tested on board torpedo gunboats, and the report itself, in paragraph 6, calls attention to the fact "that the experiments observed by the committee did not permit it to conclude that the types in use on board the topedo gunboats could be applied with equal success on board larger vessels;" it is again pointed out that the type (*a*) adopted for vessels on the stocks differs essentially from the type tested under the above conditions.

In regard to the other two proposed types (*c*) and (*d*), neither of them have been tried in the British fleet.

In the absence of any comparative experiment judged sufficient by the committee, that is, without a sufficient basis to establish a direct comparison, one has the right to ask how the committee has reached a conclusion of the inferiority of one type as compared to the others and demanded its exclusion from all future constructions, and, in fact, after how many days of trials and navigation will the Admiralty have gathered together as numerous and detailed information touching other boilers as it now possesses in regard to the Belleville boilers on board its own fleet and foreign vessels? How long before it will consider itself sufficiently advised in regard to safety, cost of maintenance, risks of obstruction and corrosion of types it has not yet had the opportunity to experiment with on board large vessels?

How, then, can it at present substitute, with any chance of better success, any boiler system whatsoever for that of the Belleville boiler?

In the British navy there are many other installations in use besides those on board the seven vessels inspected by the committee. Battleships and cruisers on service in Chinese waters are fitted with Belleville boilers that give entire satisfaction. The Admiralty would only be doing an act of justice by letting the fact be known.

On the other hand, we should not lose sight of the results of experiences obtained in other navies than the British.

It is well known that many vessels in the French navy fitted with the Bellevilles have accomplished distant cruises one after another, and always with good results.

Several of these large French vessels are at this moment in Chinese and Japanese waters, and it would not be a difficult matter for the British Admiralty to obtain official knowledge of the performance of these boilers in actual service.

In the memorandum accompanying the present communication mention is made of the principal missions accomplished by a number of those French vessels.

In another navy a recent fact is worthy of quotation: The Japanese admiralty, after accepting at Yokosuka the cruiser *Azuma*, built in France and fitted with Belleville boilers, wrote an official letter to the builders congratulating them upon the excellent results obtained on this maiden voyage with only a Japanese crew.

Finally, I might quote the results obtained on voyages made by the mail steamers of the Messageries Maritimes using Belleville boilers. The committee is not ignorant of the results obtained, for it sent three of its members to Marseilles, who inspected in detail the boilers of the *Indus* on the eve of her departure and those of the *Laos*, just in port after her regular trip to China and Japan. The commissioners of the committee had an opportunity to observe the perfect condition of the apparatus of these mail steamers. They were able to state, for instance, that on board the *Laos*, the oldest of the vessels fitted with economizers, the tubes of the latter, after three years' constant service, showed no corrosion. I may be excused for expressing my regrets that the fact was not distinctly mentioned by the commissioners in their report.

At the request of the Admiralty, one of its engineer inspectors, Mr. Pitt, a passenger on board the *Indus* on his way to China, was authorized by the company, Messageries Maritimes, to watch the performance of the boilers and engines of that steamer during the entire voyage. The Admiralty must undoubtedly have received from that officer precise information in regard to the working of the Belleville boilers that came under his immediate observation. It would be of great interest if the truth, whatever its nature, was published as widely as the report of the committee.

I append to this communication data of the number of miles run, from the day they went into service, by each of the vessels of the Messageries Maritimes that are fitted with Belleville boilers. In no instance have any of these vessels been laid up owing to their boilers.

The Admiralty will no doubt admit that the foregoing presents an ensemble of known and important facts worthy of being taken into consideration, and that in face of results so numerous, so satisfactory, and so concordant no consideration will be taken of the proposition of the committee to cancel the order for Belleville generators for vessels whose construction has just been determined upon, there being no other type of generators offering to competent men and the public in general results of practical experience in daily service as numerous and conclusive as those I have just briefly enumerated.

Sir: As a sequel to the letter I have had the honor of addressing you on the 23rd of March, on the occasion of the interim report of the water-tube boiler committee, I take the liberty of communicating to you the observations suggested to me by the examination of those portions of the report that bear specially upon the technical questions. I shall first examine the criticisms enumerated in paragraph 9.

(*a*) Circulation, says the report, is defective and unreliable, owing to the resistance offered by the great length of tube between the feed and steam collector, the friction of the junction boxes, and the small holes in the nipples between the feed collector and the generator tubes, which also are liable to be obstructed, and may thus become a source of danger.

Had not the Belleville boiler yet entered the field of practice, the fears thus expressed might be explained through theoretical conceptions that I could easily overcome with arguments and figures; but it must be remembered that the Belleville boiler has been the longest in use of all the water-tube boilers, and that a great many have been in constant use for quite a number of years on land as well as afloat, and have given practical and satisfactory results. This certainly would not have been the case if circulation in the boiler had not been normal and reliable.

We have on several occasions made experiments in our shops, in which circulation in the elements of our boilers has been the object of our closest investigations; we have verified its mechanism and intensity; we have notably established the fact that the quantity of water circulating in the elements is from six to ten times greater, according to the rate, than that of the water evaporated. This water surplus passes into the upper collector from where by external return pipes it flows back into the lower part of the elements whose feed is thus secured through a superabundant inflow of water.

These direct tests, as well as the results of practice, clearly confirm the reliability and regularity of the circulation in the circuit formed by the feed collector, the evaporating elements, the upper collector, and external return pipes of the Belleville boiler.

In regard to the small diameter of the nipples placed at the bottom of each element, it secures the even distribution of the feed water among them; the committee fears that this small diameter may cause obstructions, but it is only necessary to state that in generators of average power adopted for large vessels this diameter exceeds 40 millimeters (1.57 inches), which is much greater than the interior diameter of the boiler tubes in use in torpedo boats and destroyers, and larger also than the annular space between the tubes of boilers with concentric tubes. The risks of obstructions would thus appear to be much less in the Belleville type than in others.

(*b*) The use of an automatic feed is also criticised by the committee. But all water-tube boilers, owing to the small amount of water they contain, require regular feeding proportionate to the consumption of steam, and it is practically impossible to obtain that result by regulating by hand the quantity of water introduced. It must be remembered that in squadron manœvres the changes of speed are incessant, and that in action the position and speed of a vessel may change at every moment. How can one conceive that under such conditions there would be sufficient personnel of experience to regulate by hand the feed of all the boilers of a large ship? Automatic feed is made imperative for every water-tube boiler on board men-of-war. Even with ordinary speeds, boilers of small volumes, of whatever type, when coupled together in one single installation, can not all at the same time have the same steam pressure, because the firing is never the same at the same moment. This circumstance also renders the feed regulator necessary in order that, in spite of the differences of pressure, the feed takes place in all the parts, according to the needs of each. When the automatic feed regulator is properly made and kept in proper order and the water pressure sufficient, it is an instrument that insures perfect safety, and in which one may place entire reliance. The above is so true that on board the steamers of the Messageries Maritimes, contrary to positive instructions, the personnel often make round trips with the water-gauge cocks completely closed, relying entirely upon the feed regulator, only examining now and then if it is working regularly. This practice, which of course we condemn, has never been the cause of a single accident.

(*c*) According to the report ot the committee, the Belleville boiler requires an extra pressure in the feed pipes and in the pumps, relatively to the pressure in the boilers, and that constitutes a disadvantage. The excess of feed pressure is useful in every installation comprising a number of water-tube generators fed by the same pump, whatever the system of boilers. That pressure aids the feed regulator in securing a perfect feed in each boiler, in spite of the slight differences of pressure which unavoidably take place under steam, owing to the variations in firing and cleaning of fires. With a sufficient feed pressure we are certain that the boiler with a momentary higher pressure of steam will be fed with as much reliability as the one with the lesser. That excess in pressure does not constitute an obstacle, for all good builders are now familiar with the use of high pressures, and are quite capable of furnishing without any difficulty all the piping, joints, and pumps under proper conditions to stand the pressures used. A few atmospheres in excess would present no difficulties for any constructor.

(*d*) It is the same in regard to the excess pressure in the boilers relatively to the pressure in the engines. That difference is useful in all types of water-tube boilers in case of the absence of large volumes of water. That extra pressure permits, either the maintenance of a regular pressure in the engines, with the aid of the pressure regulator or reducing valve, and in spite of irregularities in firing; or a reserve of steam power for a sudden increase of consumption. There was a time in the French navy when they objected to overpressure in the boilers, but it was soon admitted that this was a mistake, and now the large vessels of recent date are all provided with reducing valves, even when they are not fitted with our generators. The regularity of the work of the engines, secured by the use of reducing valves, is considered a great advantage when steaming in squadron formation.

(*e*) The water gauges, says the report, do not indicate with certainty the amount of water in the boiler. This has led to serious accidents. If referring to water gauges ill kept or obstructed, this reproach should apply to all boiler systems without a single exception, but if only water gauges properly kept are considered, the reproach is undeserved. The water gauges of the Belleville boilers give practically exact indications of the volume of water contained in the generators.

(*f*) For the same level shown on the water gauges, the quantity of water contained in the boiler is well determined at different rates of combustion. When combustion increases or decreases the amount of water varies naturally and automatically in the generator, so that the circulation and the state of the steam remain always within the most practical conditions, maintaining in this manner circulation in the elements at a proper ratio with the intensity of combustion, without the least interference on the part of the firemen on watch. This arrangement, far from deserving criticism, presents, on the contrary, a notable advantage, owing to the constant state of the steam in the boiler being obtained naturally without the medium of any mechanism or the men on watch.

(*g*) The report speaks of the necessity of providing separators with automatic blow-out valves on the main steam pipes to provide for water thrown out of the boilers when speed is suddenly increased. This is a mistake. The Belleville boiler, which does not contain one volume of still water in its steam chest, is less exposed than any other to priming when speed is suddenly increased. Everybody, on the contrary, is aware of the precautions necessary with the cylindrical boilers, as well as with boilers having their water gauges in the upper steam chest to provide against priming when the speed of the engines is suddenly increased. The use of separators with automatic blow-out valves is nevertheless an excellent precaution, from the point of view of good working of the engines, as well as their preservation, in order to prevent the water condensed in the pipes, the number of which increases every day, from reaching the cylinders. Besides, when the tubes of the condensers leak and the return of salt water is considerable, it is only necessary to raise the water level in the boilers to increase water circulation in the elements and thus prevent the sediment of salt in the tubes and the corrosion that might cause their deterioration by heat. In this case the steam comes from the boiler more saturated, condensation in the pipes is greater, and the automatic blow-out valves prevent that condensation, even when excessive from being injurious to the engines.

(*h*) The committee then complains of the constant trouble and loss of water resulting from the nickel sleeve joints connecting the elements to the feed collectors. These troubles and losses of water are practically unknown on board vessels using the Belleville boilers constructed in France, and where the necessary rules for the running and care of the engines are properly carried out. The members of the committee sent to Marseilles had an opportunity of finding this out during the examination they made on the mail steamers *Indus* and *Laos*. The engineer inspector, Mr. Pitt, must certainly have observed this point during his voyage on the *Indus*. It would be interesting to learn what conclusions he formed on the subject. Assuredly, the defective construction of the cones on which the nickel jackets rest, improper fittings, or the use of brittle metal may cause leaks; but these defects can easily be avoided. Leaks might also be caused through the lack of proper care, allowing saline deposits or grease to accumulate in the lower tubes, so that the metal would be overheated and the tubes distorted. When a great amount of salt water is returned from the condensers, the saline deposits are easily prevented by timely blowing out, and the grease deposits can be prevented by the use of filters. The losses of water referred to in the report are a drawback practically unknown where proper precautions are taken in construction and in the care of the boiler.

(*i*) The committee also complains of the liability of the upper generator tubes to fail by pitting or corrosion, and the still greater liability of the economizer tubes to fail from the same cause. The question of corrosion is not special to the Belleville boilers. For a long time it has been a standing one in all navies and in all types of boilers. Numerous cylindrical boilers have had their tubes destroyed from this cause. No tubular boiler, be it fire-tube or water-tube, is therefore exempt from the risks of corrosion; but in no type has the question been longer studied and with better results than in the Belleville. The rules laid down by us for the preservation of the tubes are simple in the extreme. They consist in filling the boilers completely and keeping them so filled when at rest, and in using lime in the feed water in sufficient quantities to keep it alkaline. These directions form part of the regulations in the French navy for water-tube boilers of all types. With boilers provided with economizers, it would be advisable to add a bar of zinc to each tube of those elements. How is it that such simple precautions were not taken right from the beginning on board all the vessels of the Admiralty? How is it that many engineers have denied the efficacy of these precautions taught by experience? Why is it that these measures are not strictly applied on board all vessels fitted with Belleville boilers? This is a puzzle to us, but the fact should be radically and immediately set right. The Belleville boilers can not be made responsible for the consequences of willful disregard of our most positive practical recommendations. On the other hand, the committee confesses, in paragraph 11, that the engineer officers in charge of the Belleville boilers have not been made acquainted with the best methods of working the boilers, and with that which experience has shown to be the most effectual in preventing pitting and corrosion of tubes. I must add that some engineers, though familiar with the measures to be taken, paid no attention to them, and it would appear that these officers had no faith in these precautions. Nevertheless, results obtained on board numerous men-of-war and merchantmen prove the efficacy, as the delegates of the committee were able to verify on board the *Laos* of the Messageries Maritimes, whose economisers, after three and one-half years of uninterrupted service, were opened and carefully examined by them.

(*k*) The upkeep of the Belleville has so far proved to be more costly than that of cylindrical boilers; in the opinion of the committee this excess is likely to increase materially with the age of the boiler. The inexperience of the personnel, pointed out in paragraph 11 of the report, plays such an important part in the question of the upkeep that it is impossible to find in the conditions outlined by the committee on the vessels inspected by them a basis for an appreciation of that question. For instance, several of the vessels mentioned in paragraph 8 have met with certain accidents to the boilers that were evidently caused by defective construction or bad management. The upkeep will certainly decrease instead of increasing as soon as defects are rectified and the personnel becomes more familiar with the handling and care of the Belleville boilers. In comparing the expenditures in Belleville and cylindrical boilers, account should be taken of the enormous expense incurred in replacing the latter when they become worn-out, and the immobilization of vessels made necessary when repairing. The Belleville boilers, on the contrary, can be repaired even in the course of a cruise, and at any rate without interfering with the hull.

(*e*) The paragraph under this head in section 9 of the report ends with the remark that the committee are not prepared, without further experience, to say to what extent their observations may not apply to other types of water-tube boilers. Under these circumstances the examination of the observations contained in this paragraph presents much less interest than those preceding. They are as follows:

The Belleville boilers require additional evaporating plant. This condition has not been remarked in other navies and merchant marine, where conditions are the same from that point of view, whether Belleville or other types of boilers be considered. The mail steamers of the Messageries Maritimes have no other evaporating plant besides what would be required for the use of the crew and passengers. The remarks of the committee are therefore the results of exceptional conditions, for which the Belleville boilers are nowise responsible—for instance, leaks, traceable to faulty construction or bad management, or, again, the increasing use of auxiliary engines and the extensive number of pipes they require. The wide differences that have been noticed in the consumption of water on board various vessels, according to the manner of performing the service, prove that these consumptions should not be attributed to the boilers alone.

2. The greater consumption of coal of the Belleville boilers under ordinary conditions. We have not sufficient data to enable us to discuss that point. It can not, however, be denied that at the time of the experiments of which an account appears in the official document published by the Admiralty, better results were obtained with the Belleville than with cylindrical boilers. Why should not the same relative results be obtained in everyday service? We can account for it only by the perfect knowledge the personnel has of the cylindrical boilers, and its lack of instruction in the management of the Bellevilles. It is also possible that the proportions adopted for the firebars on board vessels of the royal navy are not suitable from the point of view of results sought at ordinary rates of combustion. These bars are approximately 15 millimeters (0.59 inch) wide and the same distance apart. During trials the use of broken coal and the care given to firing permit obtaining with these grates satisfactory results, but even ashore that proportion is not satisfactory. During trials ashore with two generators of the *Powerful*, at Barrow, our principal engineer obtained very efficient results by reducing the space between the bars. Under ordinary conditions coal is used as it comes, and the fires are conducted with much less precision than during trials limited to time; the disadvantages of the too wide spacing of the bars thus become more apparent; besides, a great deal falls through the spaces between the bars and at the same time these spaces give free passage of air to parts of the grate momentarily not covered with coal. These conditions are particularly objectionable in furnaces where the flame ascends vertically, especially if the apparatus for injecting air over the grates is not used. This cause operates all the more as the personnel is less familiar with the management of furnaces from which the flames ascend vertically, and fails to carry out our instructions in regard to the use of apparatus for mixing the gases.

3. In consequence of the preceding two points, the committee doubts that the economy in weight obtained in the construction of water-tube boilers corresponds in reality with an increase in the vessel's radius of action. This increase of radius of action will become effective when the personnel of the fire room is better able to manage the new boilers intrusted to its care. This consideration very likely caused the remark of the committee that probably the observations made in paragraph 1 apply in the same way to the various types of water-tube boilers.

Paragraph 11 of the report of the committee is certainly one of those that will attract most the attention of the Admiralty and the public. The committee, in the first place, give out the opinion that in order to obtain a more satisfactory working of the Belleville generator more than ordinary experience and skill are required on the part of the engine-room staff. The latter should, at any rate, acquire different experience and different notions from those acquired in the management of the cylindrical boilers. The new water-tube boilers, including the Belleville, are indeed different in their principles, in their construction and working, from the old boilers. The management of the fires is different in furnaces with ascending flames from that in furnaces with horizontal flames. New engines require new practical instruction.

In my letter of the 13th instant I called the attention of the Admiralty to the fact that in other navies this instruction is the natural result of the extended intercourse between the engine-room staff of the vessel and our engineers and fitters during the fitting out and trials of the boilers; a continuous exchange of information takes place during which all the apparatus is successively examined and explained and all the conditions of rates of combustion tried, one after another, to the great advantage and instruction of the engineers. It is certain that the constructors to whom the Admiralty intrusts the building of the boilers are not as well acquainted as our own with the details of construction and service; that they are less impressed with the importance and raison d'être of each part, and consequently less apt to appreciate their importance. In the absence of this natural instruction some measures should certainly be taken to enable the engineers of the fleet to obtain the best results with the apparatus intrusted to them.

Paragraph 12 of the report proposes the following questions, the same as were made by the Admiralty in their letter to me of the 6th of March: Suppression of the economisers and a return to the type of the *Powerful* for vessels under construction; second, adoption of a deeper furnace; third, increase of the diameter of the steam collectors. Although I hastened to answer from Cannes on the 13th instant the Admiralty's communication on the subject, I think it useful to revert to these three points with additional details.

In the first place, even if at the lower rates of combustion, those most in use in daily service, the consumption of the economiser type should not be more advantageous than that of the noneconomiser types, the advantage is so great at higher rates of combustion that that single reason would justify the retention of the new type. To be sure the coal economy at the lower rates of combustion is, in ordinary circumstances, interesting from the point of view of money expenditure; but in time of war the economy of coal supply at high rates is still more important. That consideration seems to me conclusive; it was so judged by all competent men when I undertook the study and pursued my tests of the economiser type. On the other hand, the experiments made with the latter have given, even at moderate rates, far better results than the other type. These experiments have been repeated over and over again, not only under the control of the engineers of the Admiralty, but also under the control of the engineers of the French navy and various technical associations. The concordance of the results leaves no room to doubt their accuracy. If in the experience of the Admiralty the same results have not been realized in service, I can only attribute the fact, to a great extent, to the inexperience of the personnel, which has brought about such poor results as to confuse comparisons. The size of grates may have contributed to abnormal consumptions of coal in ordinary service in both types, and given misleading results.

In regard to the adoption of deeper fire boxes than those described in the cuts forwarded by us to the Admiralty, I had the honor to ask you, in my communication of the 13th instant, what observed facts warranted the change. I find nothing of the kind in the committee's report, and that no tests have been made to study the question. This must, then, be a simple conception of theoretical conditions to which I oppose our numerous tests and our long experience with our generators. If it were a question of using coke or anthracite, the increase in depth of the furnaces might prove advantageous. On the contrary, it would be disadvantageous in case of using bituminous coal, owing to the increase of radiating surface of the furnace, which would cause too quick liberation of the gases, rendering their combustion more difficult. For the same reason the clinkers would be hotter and more fusible, and hence the cleaning of the fires more laborious. From another point of view, a greater depth of fire box would demand a higher front and consequently a greater area of the exterior radiating surface which is the hottest and the nearest to the men. That condition would tend to make the firemen's lives more intolerable.

Finally, a greater diameter of the collectors would necessitate greater thicknesses and consequently an increase in weight. We have tried steam collectors of various diameters and finally decided upon the one in use, having found no advantage in larger types. In the absence of new facts I am therefore of the opinion that the present diameter should be adhered to. A very slight increase—five centimeters, for instance—would, of course, have no other disadvantage than that of increasing the weight and volume.

In paragraph 13 the report recommends, for furnishing steam for auxiliary purposes, the use of special cylindrical boilers instead of water-tube boilers. The question is of no great importance, as I think that the type of boiler has but little influence on the consumption of fuel used for this purpose. What is more important is the reduction, as far as possible, of the number of the auxiliaries, their efficient use of steam, their grouping in order to reduce the length of steam pipes, the use of exhaust steam, and, above all, the substitution of electric power for steam power wherever practicable.

SERVICE PERFORMED BY FRENCH VESSELS FITTED WITH BELLEVILLE BOILERS.

Voltigeur, dispatch vessel; in commission from 1880 to 1886, with an exception of an interval of ten months.

Milan, cruiser; in commission from 1882 to 1890 and from 1892 to 1898; fourteen years of active service.

Hirondelle, in commission from 1890 to 1895.

Amiral Rigault-de-Genouilly, cruiser; attached to the Flying Division of the Atlantic from 1891 to 1898; with four cruisers in the Atlantic Ocean and Newfoundland waters, from 1893 to 1897.

Léger and *Lévrier*, torpedo vessels, have constantly been attached to squadrons from the date of their commission (1892) to December, 1899, or seven and one-half years' continuous service.

Alger, cruiser, first class; in squadron from date of commission (1893), with a cruise of twenty-eight months in the Orient from October, 1894, to February, 1897. She returned from that cruise in perfect condition.

Latouche-Tréville and *Chanzy*, armored cruisers; in commission since 1895; five years.

Amiral Charner, cruiser; in commission since 1895; at present in Chinese waters; five years' service.

Brennus, battleship; squadron duty since 1895.

Amiral Tréhouart, coast-defense vessel; squadron duty since 1896.

Bruix, cruiser; placed in commission in 1896; after a cruise in the Orient from February to December, 1898, returned, having accomplished her mission.

Bugeaud, placed in commission in 1896; ordered to China in February, 1900, after four years in service.

Descartes, cruiser; in commission since 1896; has been on China Station since January, 1897.

Pascal, cruiser; in commission since 1896; has been on the China Station since January, 1898.

Amiral Pothuau, cruiser; on squadron duty since June, 1897.

Galilee, cruiser; squadron duty since September, 1897.

Bouvet, battleship; squadron duty since March, 1898.

Lavoisier, cruiser; squadron duty since April, 1898.

Catinat, cruiser; squadron duty since acceptance trials May, 1898, to end of 1899.

Protet, cruiser; sailed from Rochefort in 1899 for a cruise in the Pacific, and is still on that service (December, 1900).

Charlemagne and *Gaulois*, battleships; squadron duty since their final trials January, 1900.

Saint-Louis, battleship; squadron duty since September, 1900.

BELLEVILLE BOILER (ECONOMISER TYPE).

REFERENCES.

A B C, boilers placed side by side.
a b, generator tube sections of boilers A B.
A^1 B^1 C^1, economisers of boilers A B C.
a^1 b^1, tube sections of economisers A^1 B^1.
a' b', combustion chamber between generator and economiser tube sections *a b* and a^1 b^1.
b^2, air jets for mixing the gases in the combustion chamber *b'*.
A' B', self-acting feed regulator for boilers A B.

COURSE FOLLOWED BY FEED WATER (SEE BOILER B).

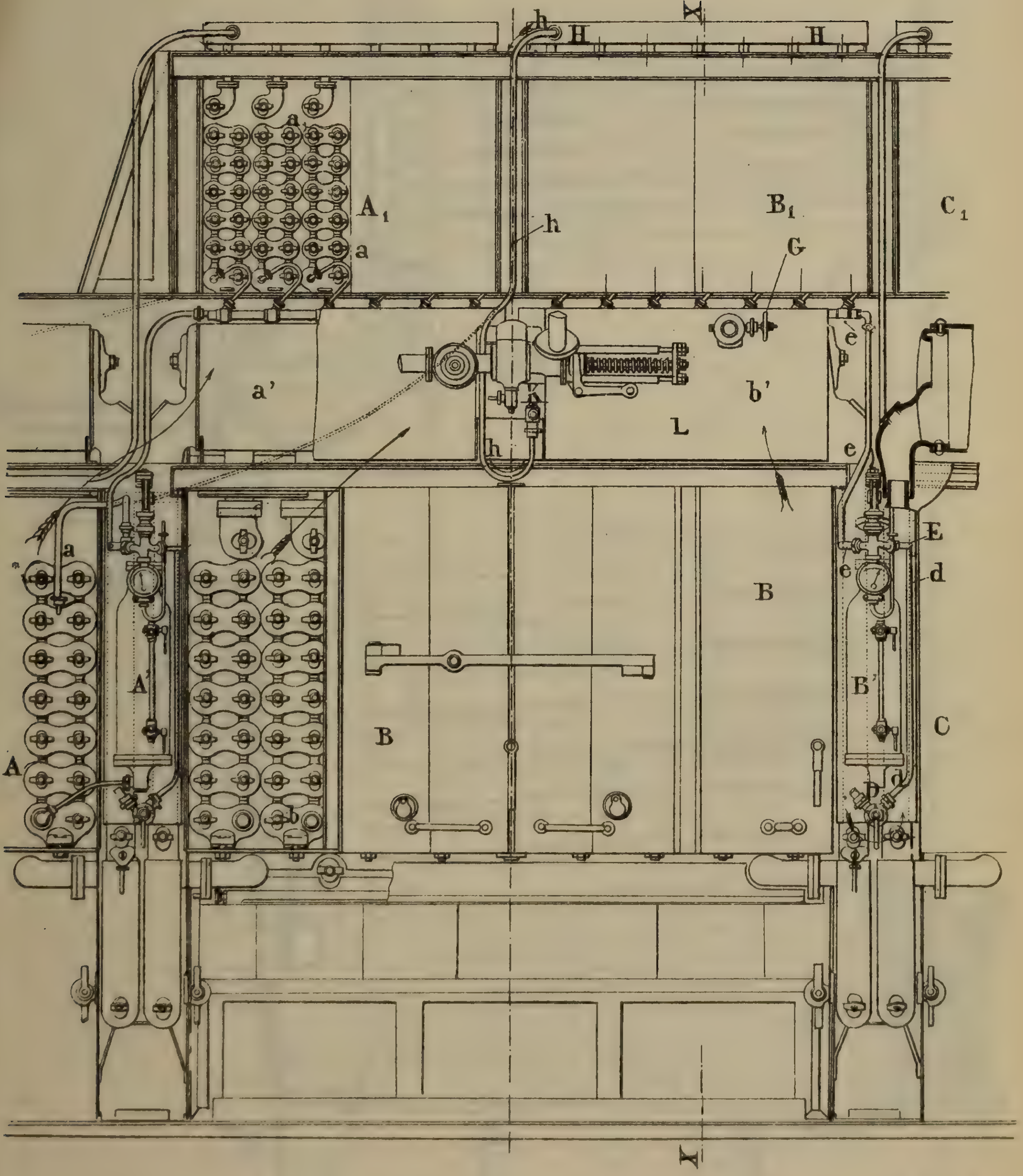
The water delivered by the feed pump passes through the feed-regulating valve D, and is led by pipe *d* to the self-acting regulator E, which suits the amount of feed to the requirements of the boiler. From the regulator E the water is led by pipe *e* to the inlet collector G of the economiser B, whence it is distributed to the economiser tube sections.

The water is heated on its way through the economiser tube sections b^1 b^1, and passes through them to the outlet collector H, and by the pipe *h* to the feed-check valve K, fitted in front of the steam collector L, as in the ordinary type of Belleville boiler.

The total horsepower of seagoing ships fitted or to be fitted with Belleville boilers is as follows:

	Number of ships.	Total horse-power.
French navy	40	371,320
The Messageries Maritimes Co	14	87,600
French Western Railway Co	7	17,900
English navy	65	1,046,400
Russian navy	31	251,300
Japanese navy	10	122,700
Austrian navy	5	56,700
Chilean navy	4	26,500
Argentine navy	1	13,000
Italian navy	2	32,500
Spanish navy	1	11,000
	180	2,036,920

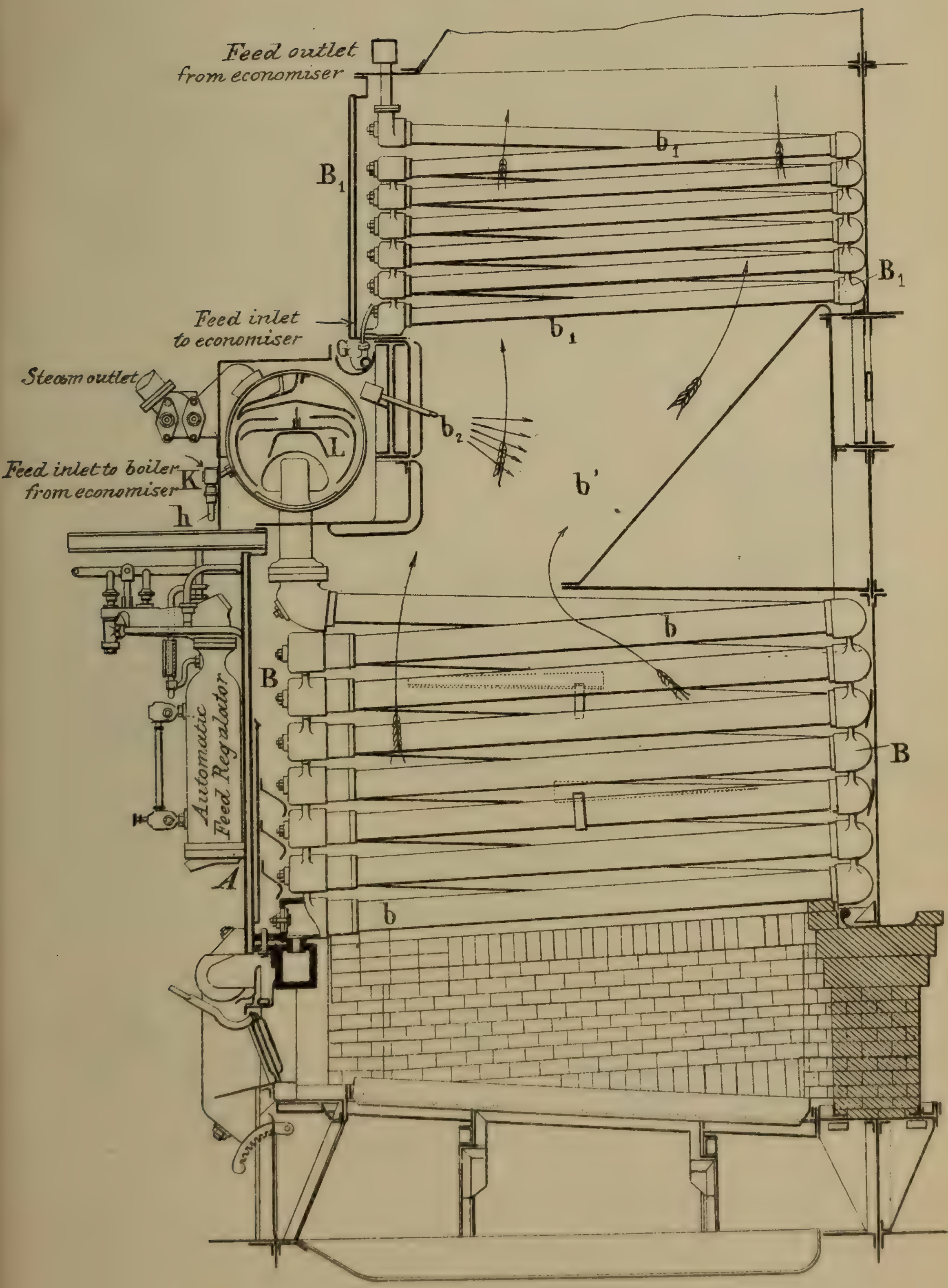
Front elevation



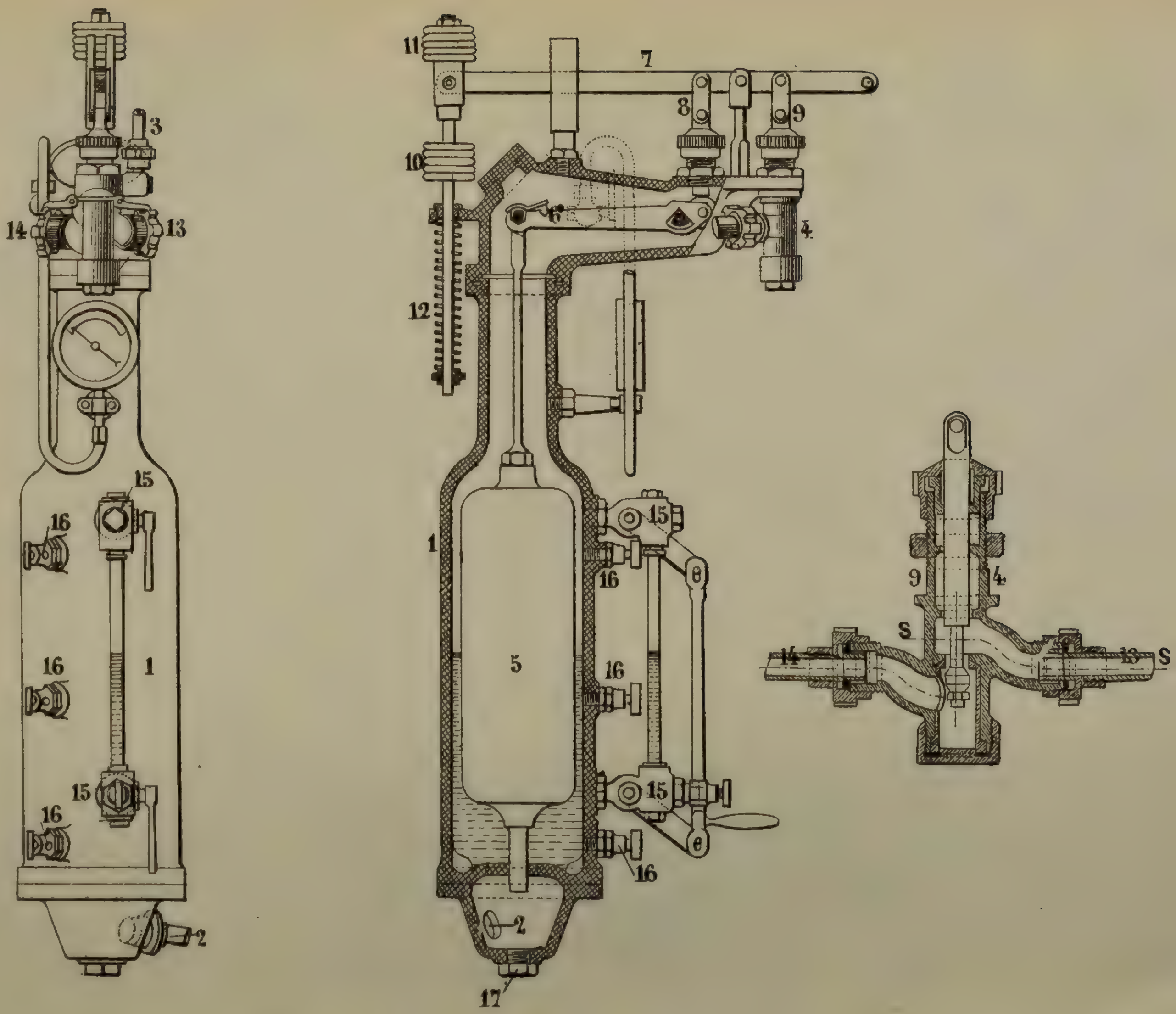
BELLEVILLE BOILER (ECONOMISER TYPE).

Side elevation

Section at XX.



BELLEVILLE BOILER (ECONOMISER TYPE).



THE BELLEVILLE AUTOMATIC FEED REGULATOR.

THE BELLEVILLE AUTOMATIC FEED REGULATOR.

1. Water column.
2. Pipe in communication with water of generator.
3. Pipe in communication with steam of generator.
4. Automatic feed valve.
5. Float.
6. Float levers.
7. Counterweight lever.
8. Connections of lever 7 with 6 through stuffing-box.
9. Connection of automatic valve with lever 7
10. Fixed counterweight.
11. Variable counterweight.
12. Spring of counterweight.
13. Feed inlet.
14. Feed outlet.
15. Gauge.
16. Gauge cocks.
17. Cleaning plug.

The rise or fall of the float acts upon the system of levers and permits the weights to open or close valve 4. When the water falls, the valve is opened, and when the valve closes, the excess water is returned to the feed tank.

NICLAUSSE WATER-TUBE BOILER.

The principal features of the Niclausse water-tube boiler are shown in the cuts.

There is a steam and water drum at the top, fitted with a diaphragm for the entering feed water.

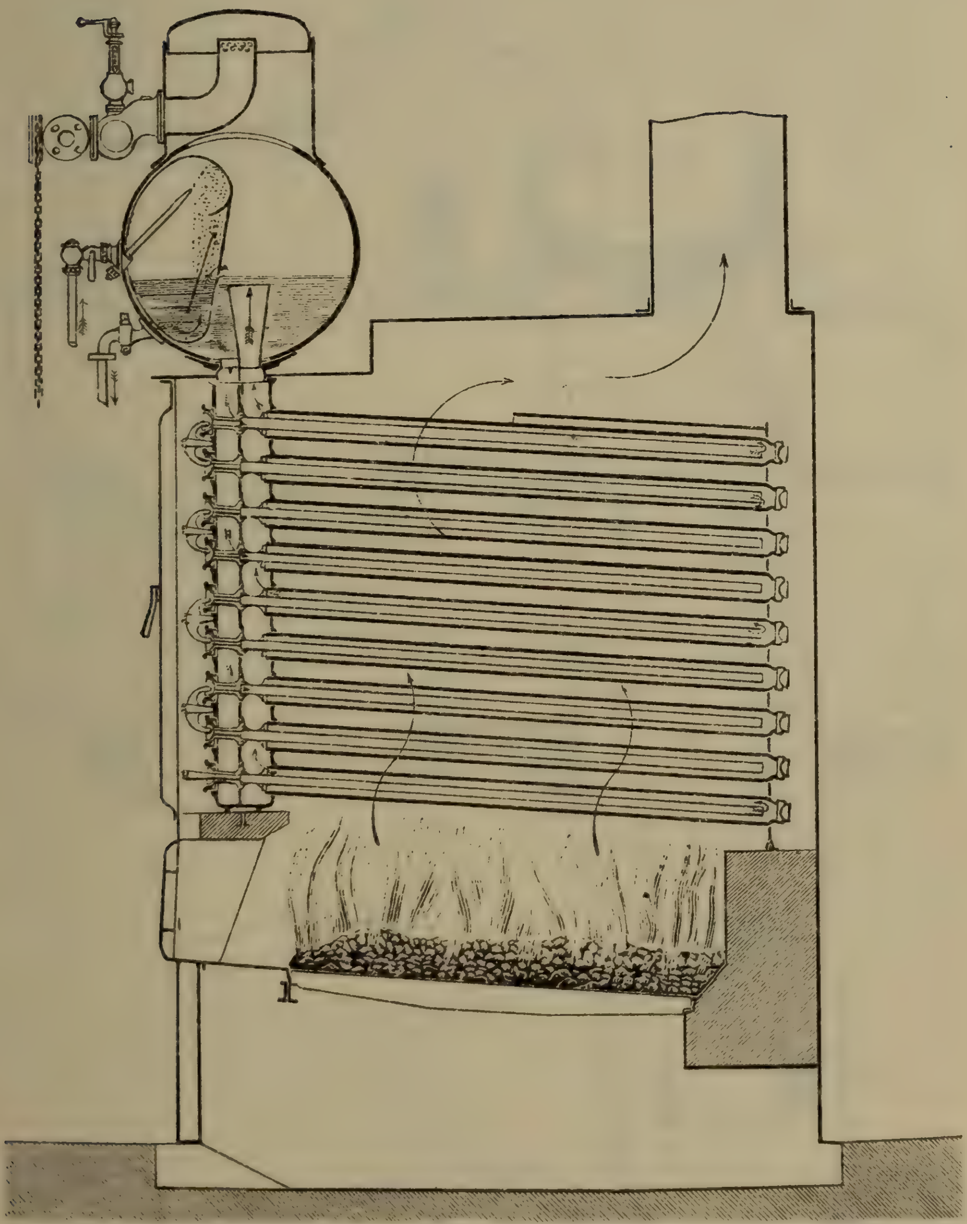
Inclined duplex tubes are used, and are made of unwelded steel in a single piece, the lanterne being punched into the tube itself. The tubes have conical ends fitting coned surfaces in the headers and are held in place by external dogs. They are interchangeable, which allows the lower tubes next to the fire to be replaced by the upper tubes. They are arranged vertically over each other, so that each group has its own header chamber, which is connected to the steam and water drum. In experiments on the *Seagull* a tube was removed and replaced by another in twenty-five minutes.

The collectors are now made of a wire-drawn tube without welding, rectangular in section, and with conical apertures for the tubes.

The circulation is indicated in the cuts. The descending feed water passes through the internal tubes, then back through the annular space between it and the outside tube, and is separated from the ascending hot water and steam.

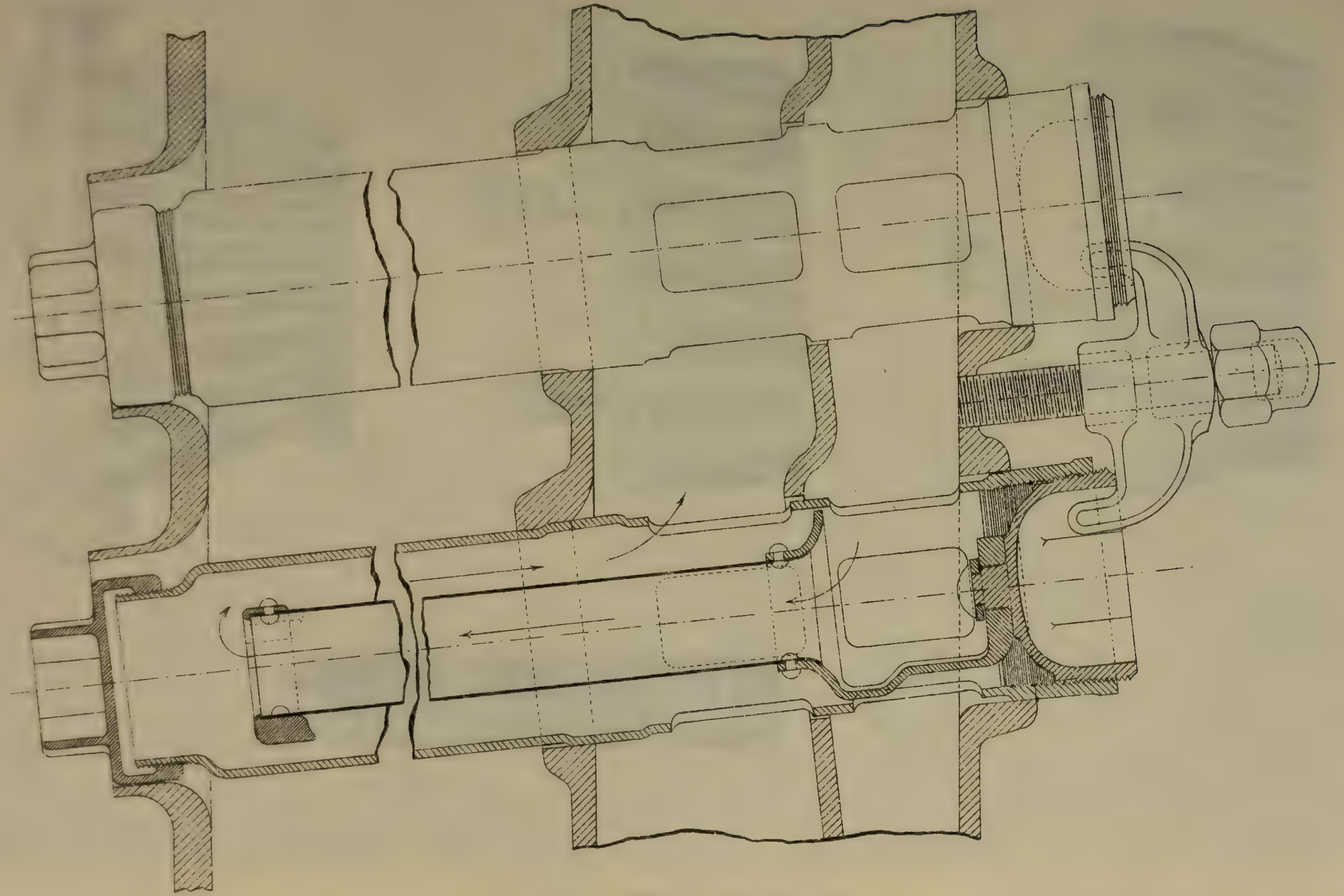
The following table shows the vessels fitted or to be fitted with Niclausse boilers:

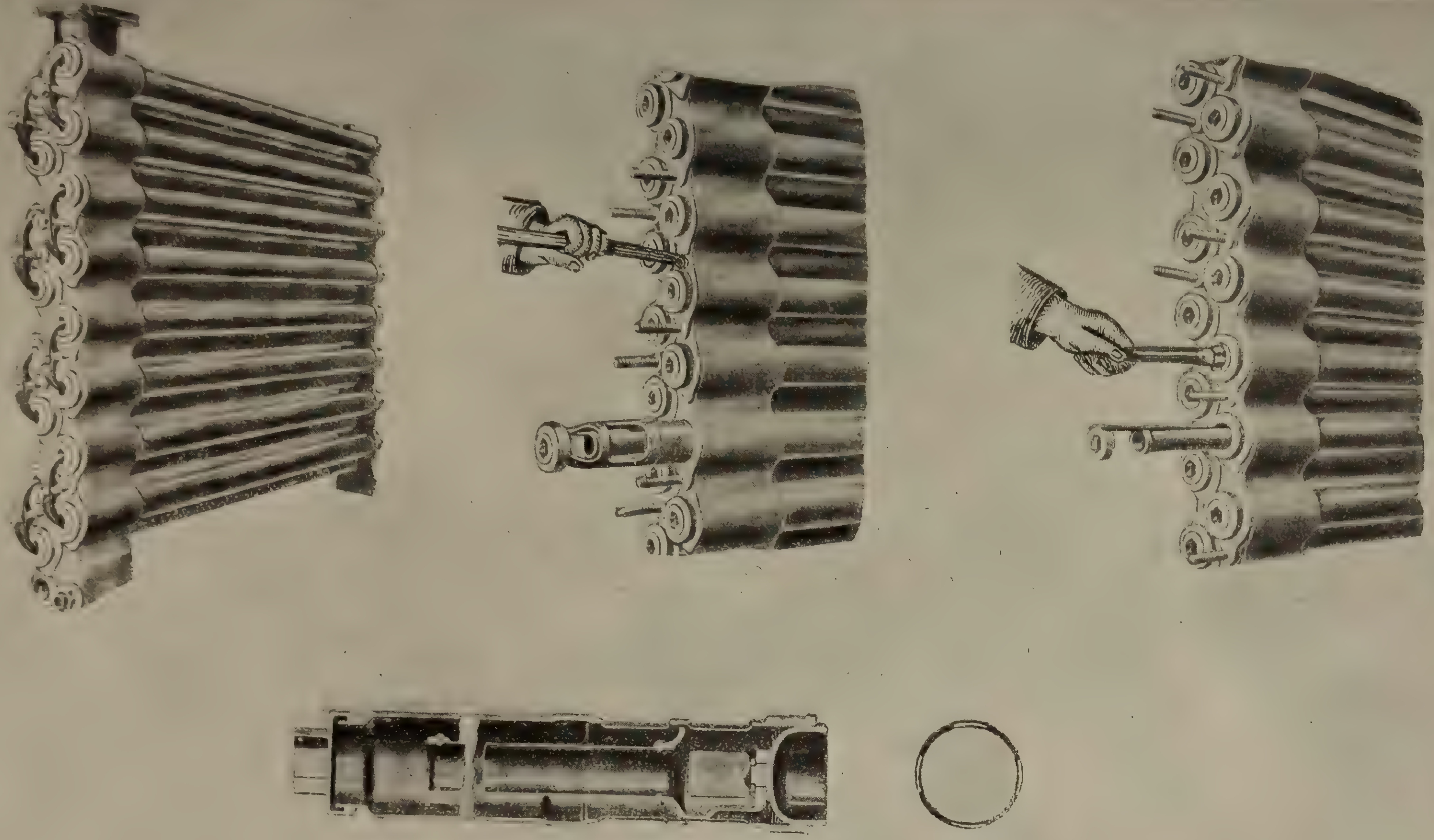
Country.	Vessel.	Horse-power.
France	Battleship Suffren	16,500
	Battleship Marceau	14,000
	Battleship Henry IV	11,500
	Battleship Requin	7,000
	Armored cruiser Léon Gambetta	27,000
	Armored cruiser Gueydon	20,200
	Armored cruiser Condé	20,200
	Armored cruiser La Gloire	20,200
	Armored cruiser Kléber	18,000
	Cruiser Friant	9,000
	Cruiser Davout	9,000
	Torpedo cruiser Fleurus	4,000
	Torpedo boat Téméraire	1,500
	Gunboat Décidée	1,000
	Gunboat Zélée	1,000
Russia	Cruiser Variag	20,000
	Battleship Retwisan	15,000
	Gunboat Khrabry	3,000
England	1 armored cruiser	22,000
	Sloop	1,400
	Gunboat Seagull	3,000
Germany	Cruiser Freya	10,000
	Cruiser Gazelle	7,000
Italy	Battleship Regina Margherita	19,000
	Armored cruiser Guiseppe Garibaldi	14,000
	Armored cruiser Francesco Ferrucio	14,000
United States	Battleship Maine	16,000
	Monitor	2,400
Spain	Battleship Pelayo	9,000
	Armored cruiser Cristobal Colon	14,000
Turkey	Battleship Messoudieh	11,000



NICLAUSSE WATER-TUBE BOILER.

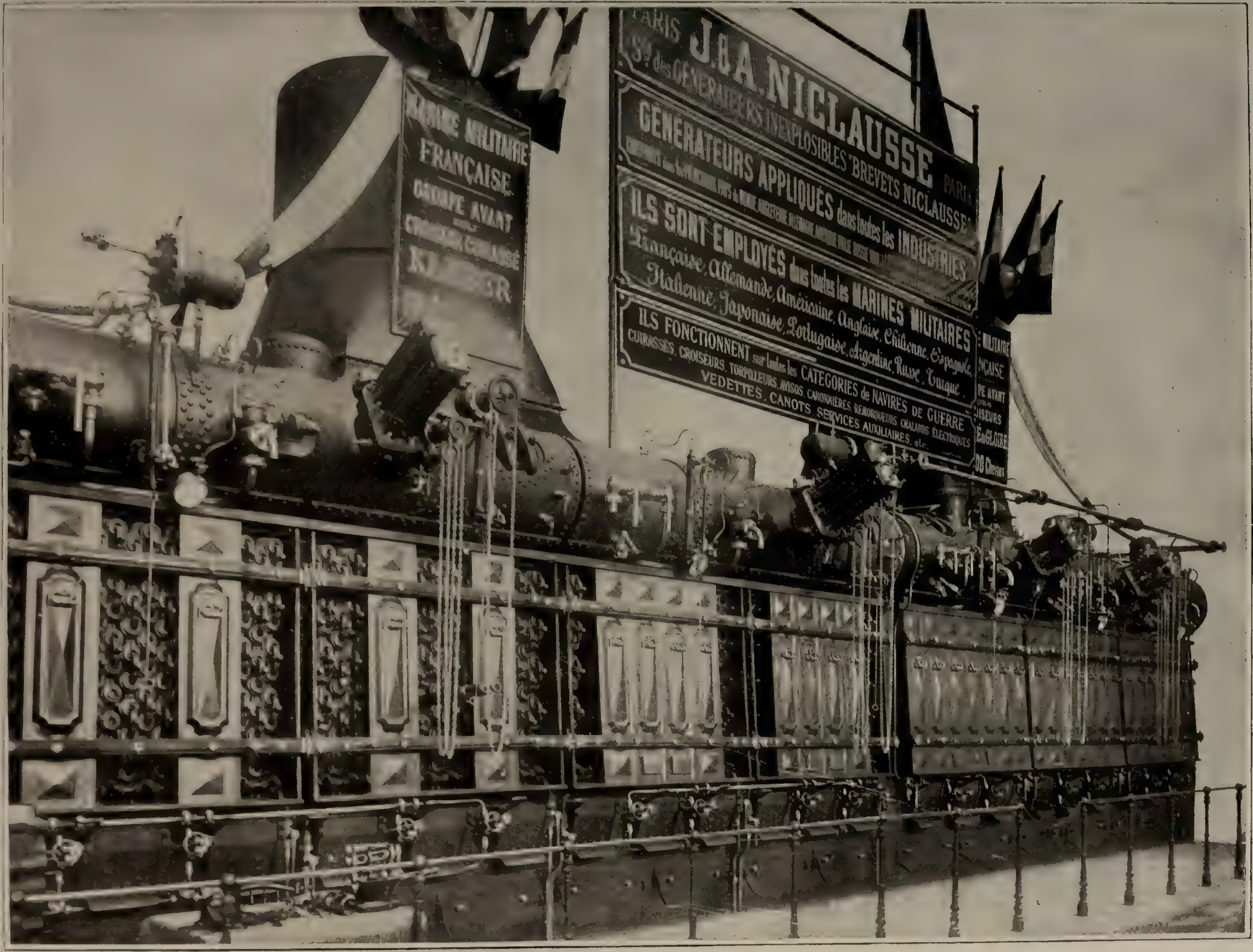
Niclausse Boiler Tube.



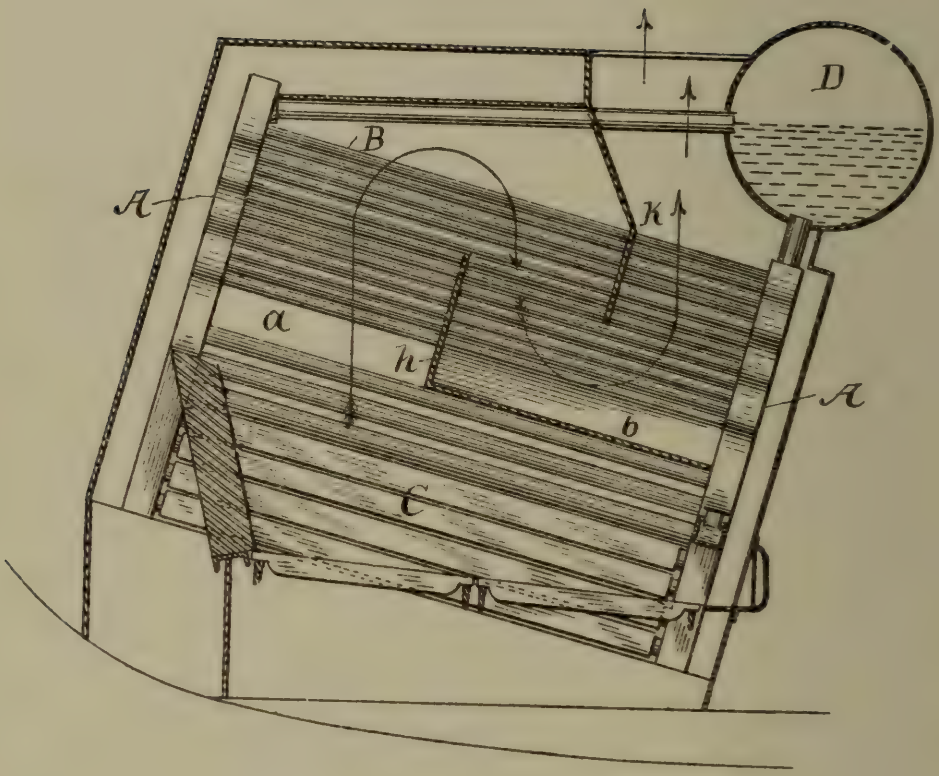


NICLAUSSE WATER-TUBE BOILER.

1. Tube element. 2. Removal of a complete tube. 3. Removal of an internal tube. 4. Section of a complete tube.


PARIS J. & A. NICLAUSSE PARIS
Sté des GÉNÉRATEURS INEXPLOSIBLES "BREVETS NICLAUSSE"
GÉNÉRATEURS APPLIQUÉS dans toutes les INDUSTRIES
ILS SONT EMPLOYÉS dans toutes les MARINES MILITAIRES
Française, Allemande, Américaine, Anglaise, Chilienne, Espagnole, Italienne, Japonaise, Portugaise, Argentine, Russe, Turque
ILS FONCTIONNENT sur toutes les CATÉGORIES de NAVIRES DE GUERRE
CUIRASSÉS, CROISEURS, TORPILLEURS, AVISOS, CANONNIÈRES, REMORQUEURS, CHALANDS ÉLECTRIQUES
VEDETTES, CANOTS, SERVICES AUXILIAIRES, etc.
MARINE MILITAIRE FRANÇAISE
GROUPE AVANT
CROISEUR CUIRASSÉ
KLÉBER

BOILER GROUPS FOR KLÉBER AND GLOIRE.



BABCOCK AND WILCOX BOILER.

BABCOCK-WILCOX BOILER.

The new type of this boiler is made of wrought steel and has the baffle plates arranged to cause the products of combustion to pass three times across the tubes before entering the uptakes. The boiler for the *Cincinnati* has tubes 2 inches outside diameter and 8 feet long, while the bottom tube in each section is 4 inches outside diameter and is 8 feet 5½ inches long. There are 526 small tubes and 40 large tubes. The total heating surface is 2,640 square feet. The grate has an undivided area of 63.25 square feet.

The following patent specifications describe the new type of this boiler:

In the accompanying drawing the figure represents a side elevation of the generator, showing the disposition of the baffles.

The relative arrangements of the main parts of the generator herein shown are substantially similar to the corresponding parts illustrated in the prior patent referred to, A A representing the headers; B, the intermediate inclined water tubes; C, the furnace, and D the elevated steam and water drum. The inclined water tubes are shown of different sizes, similar to those shown in the patent referred to, the larger tubes with intermediate spaces being located directly above the furnace.

In the present structure a greater space *a* is designed between the inclined clusters of the different sizes of water tubes to provide a chamber for greater expansion of the products of combustion and to locate the accumulation of ashes and dirt and facilitate their removal.

The furnace roof and baffle-plates are preferably arranged as shown in the drawing, the roof *b* at the top of the lower series of water tubes and at the bottom of the chamber *a* and extending from the front header partially over the furnace forming a reverberatory surface for the products of combustion from beneath, and an ash receptacle from above. At the end of the roof *b* the baffle *h* is placed, extending upward across the chamber *a* and about half the depth of the cluster of inclined water tubes. About midway of the chamber formed by the roof *b* and the baffle *h* another baffle *k* is fixed, which depends from the top of the generator and also extends about half the depth of the cluster of water tubes. This arrangement of the roof and baffles, as clearly illustrated, causes the products of combustion to reverberate within the furnace and to follow the course indicated by the arrows to the escape or uptake, and whereby the expanded gases are thoroughly circulated throughout the chamber *a* and crossed and recrossed among the inclined water tubes, and by the increased distance they are required to travel their effective heat is not only fully absorbed, but applied at the most advantageous points. This relative arrangement of the baffles is especially advantageous in association with the enlarged portion of the combustion chamber of the furnace, wherein a much greater degree of expansion of the gases takes place than in furnaces of ordinary construction, and, further, in connection with the supplementary expansion chamber *a*. This latter part of my invention also provides for the concentration of ashes and dust upon the inclined roof *b*, from which they can be readily removed through a cleaning door communicating therewith at the side of the generator.

YARROW WATER-TUBE BOILER.

The Yarrow is a boiler with "drowned" tubes. The drum runs from back to front and the tubes, which are straight, are expanded directly into it in two groups, one on each side, so that the boiler with its tubes forms an inverted V. All the tubes of each group are expanded at the lower ends into a flat-sided horizontal drum just below the fire level. The circulation is from the upper drum downward, either by special large down-comer pipes, or by the outer and less heated tubes of each group, and up again by the small tubes or those nearest the fire.

The general principles of the large tube type, recommended by the boiler committee for trial, are the same as the small tube type. The tubes in the former are of 1¾ inches outside diameter, and it weighs about 50 per cent more than the boiler used in torpedo boats.

The following table, issued by the Yarrow Company, shows to what extent this boiler is being adopted for large vessels:

Cruisers and battleships built and building with Yarrow boilers.

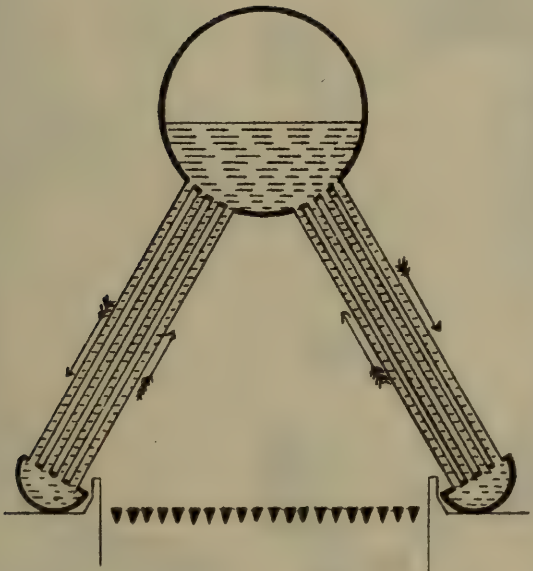
Type of vessel.	Built or building.	Name.	I. H. P.
For the Dutch navy:			
Cruiser	Built	Holland	[1] 10,000
Do	do	Friesland	[1] 10,000
Do	do	Zeeland	[1] 10,000
Do	do	Utrecht	[2] 10,000
Do	do	Gelderland	[2] 10,000
Do	do	Noord Brabant	[2] 10,000
Ironclad	Building	Koningin Regentes	[2] 6,000
Do	do	De Ruyter	[2] 6,000
Do	do	(Not yet named)	[2] 6,000
For the Swedish navy:			
Cruiser	Built	Psilander	[2] 4,500
Do	do	Clas Uggla	[2] 4,500
Armor clad	Building	Dristigheten	[2] 6,000
Do	do	A	[2] 6,000
Do	do	B	[2] 6,000
Do	do	C	[2] 6,000
Cruiser	Being designed		[2] 12,000
For the Austrian navy:			
Cruiser	Built	Zenta	[2] 7,800
Do	do	Aspern	[2] 7,300
Do	do	(Not yet named)	[2] 7,800
Do	Building	do	[2] 13,000
Ironclad	do	do	[2] 14,000
For the Portuguese navy (built by Armstrong, Mitchell & Co., Limited):			
Cruiser	Built	Don Carlos I	[2] 12,500
For the Norwegian navy (now completing by Armstrong, Mitchell & Co., Limited):			
Ironclad	Building	Norge	[3] 4,500
Do	do	Eidsvold	[4] 4,500

[1] 7,500 H. P. Yarrow boilers and 2,500 H. P. cylindrical boilers.

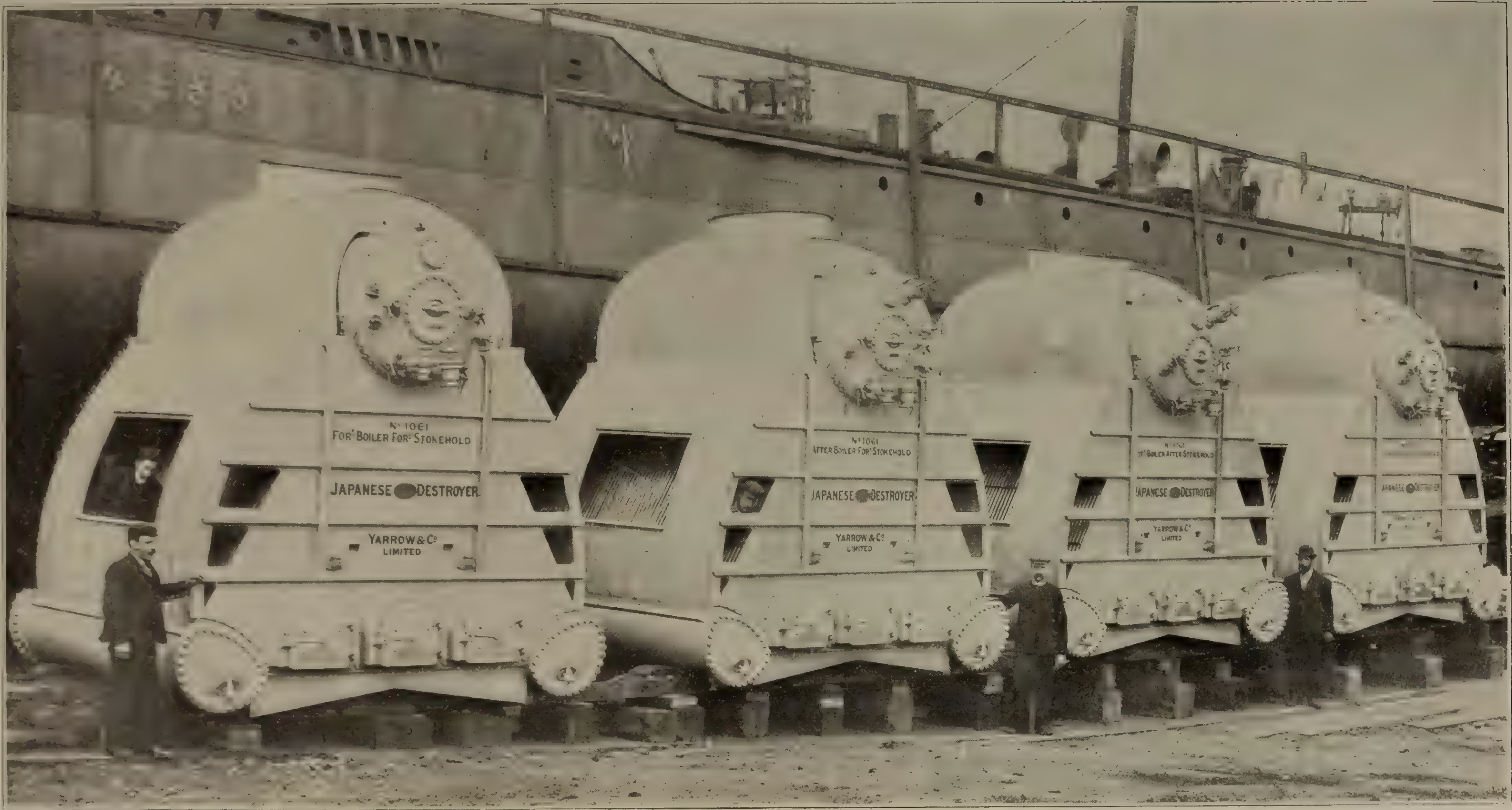
[2] All Yarrow boilers.

[3] All Yarrow boilers. Trials finished.

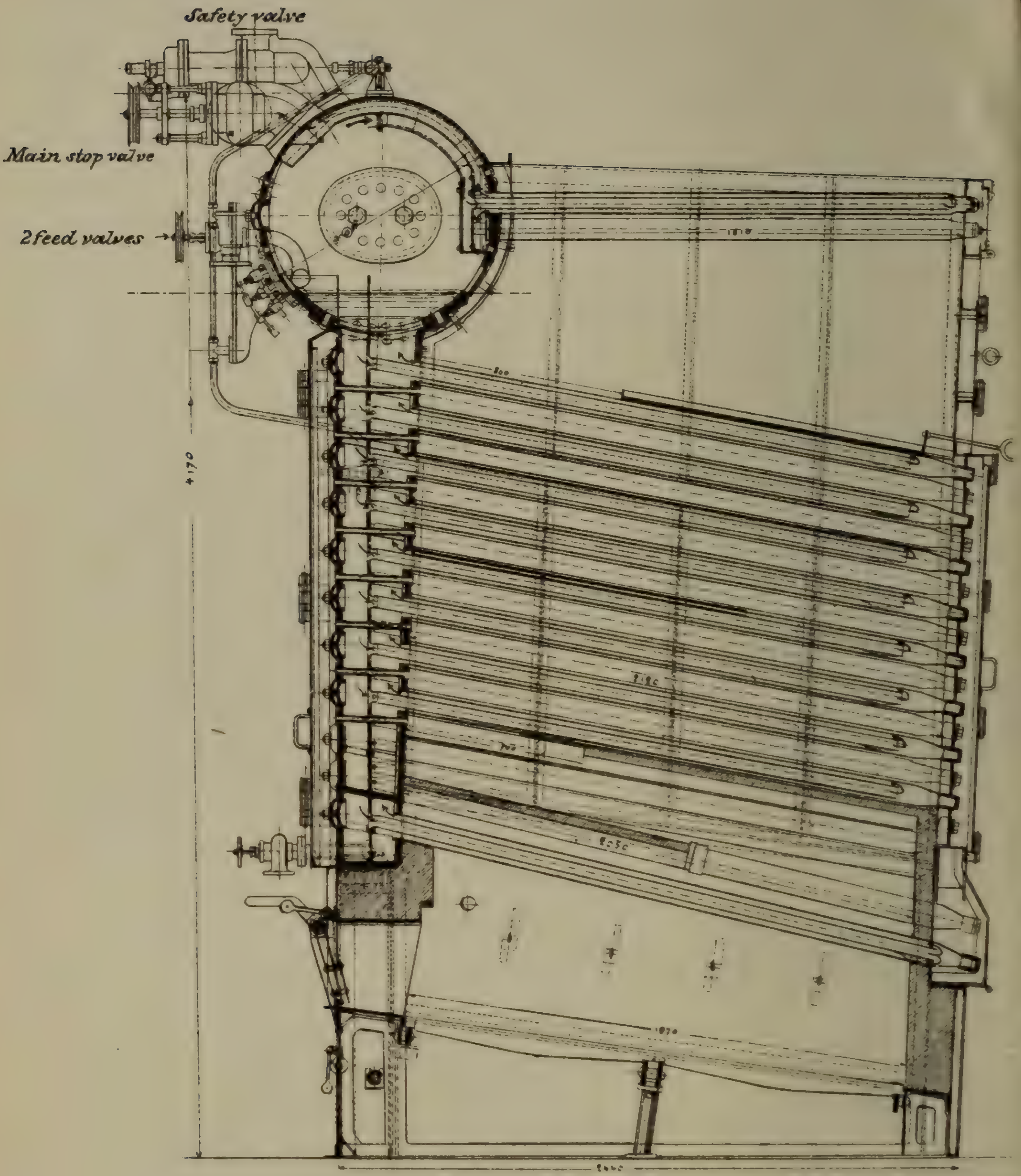
[4] All Yarrow boilers. On the point of trial.



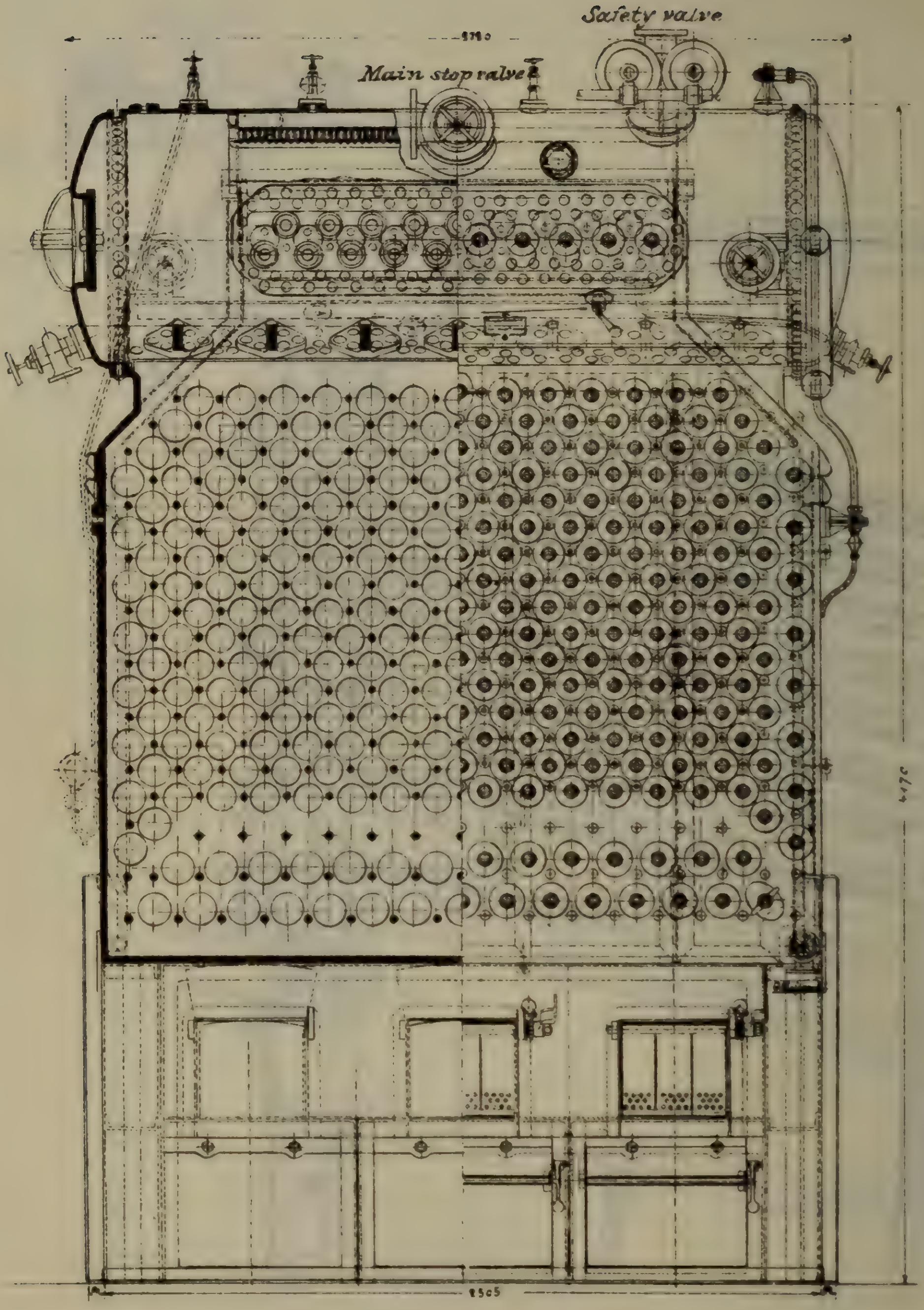
YARROW WATER-TUBE BOILER.
(Transverse section showing circulation.)



FOUR YARROW WATER-TUBE BOILERS CAPABLE OF DEVELOPING 6,000 HORSE-POWER.



DÜRR WATER-TUBE BOILER.



DÜRR WATER-TUBE BOILER.

DÜRR WATER-TUBE BOILER.

The characteristics of the Dürr boiler are a large water chamber, divided into two parts; the duplex tubes passing into the two parts of this water chamber, the collector at the top, and the superheater.

The tubes are inclined and the rear ends rest in the rear wall, so that they can expand without limit and without bending. The duplex-tube arrangement is also employed in the superheater.

The feed-water flows downward in the front half of the water chamber and through the inner tubes. The steam and hot water then pass through the outer tubes and ascend into the front part of the drum collector, where the steam enters the tubes of the superheater and in which any water that may have been carried along is evaporated.

Vessels fitted or to be fitted with Dürr water-tube boilers.

	Displacement.	I. H. P.
Germany:	*Tons.*	
Battleship Bayern	7,400	6,370
Battleship Baden	7,400	6,200
Battleship Sachsen	7,400	6,400
Armed cruiser Prinz Heinrich	8,800	15,600
Armed cruiser "B"	8,800	18,000
Armed cruiser Ersatz König Wilhelm	9,757	18,000
Cruiser Victoria Louise	6,000	11,390
Cruiser Vineta	6,000	10,650
England:		
Cruiser Encounter	6,000	12,500
Cruiser Medusa	2,800	9,000

	Victoria Louise.	Vineta.	Prinz Heinrich.	Cruiser "B."
Steam pressure—atmospheres, pounds per square inch	15	13	15	13½
Grate area, each boiler:				
Square meters	5.22	4.64	6.75	7.4
Square feet	56.1	49.9	72.6	79.6
Water-covered heating surface:				
Square meters	215.4	201.4	284.14	312.15
Square feet	2,316	2,162	3,055	3,350
External diameter of outer tubes:				
Millimeters	83	83	83	83
Inches	3¼	3¼	3¼	3¼
Length of outer tubes:				
Meters	2.12	2.02	2.04	2.13
Feet	6.96	6.63	6.70	6.99
Ratio of heating surface to grate area	41.3	43.4	42	42.8
Superheating surface:				
Square meters	16.5	11	15.7	16.4
Square feet	177	118	169	176
Diameter of collecting drum:				
Meters	.85	.90	1.10	1.15
Feet	2.79	2.96	3.61	3.77
Steam space, excluding superheater:				
Cubic meters	1.3	1.7	3.2	3.5
Cubic feet	46	60	113	124
Total weight without water, tons	18.24	20.31	29.35	31.04
Total weight with water, tons	23.05	25.31	36.85	38.74
Total weight per square meter heating surface, tons	.107	.126	.130	.124
Total weight per square foot heating surface, tons	.0095	.0117	.0121	.0115
Ditto per maximum I. H. P	.025	.028	.033	.030
Ratio of floor area to heating surface	.039	.038	.037	.036
Trial trip:				
Kilograms fuel per hour per square meter grate area	175	200	165	175
Pounds fuel per hour per square foot, grate area	36	41	34	36
Forced draft, inches w. g	1⅛	1⅜	...	...
Fuel per I. H. P. hour—				
Kilograms	.90	.96	1	1.07
Pounds	1.88	2.12	2.20	2.36
I. H. P. per square meter heating surface	4.27	4.55	3.92	4.11
I. H. P. per square foot heating surface	.397	.423	.364	.382
Normal natural draft:				
Kilograms fuel per hour per square meter grate area	68	64¾	...	...
Pounds fuel per hour per square foot grate area	14	13¼	...	...
Fuel per I. H. P. hour—				
Kilograms	.83	.93	...	...
Pounds	1.83	2.05	...	...
I. H. P. per square meter heating surface	1.47	1.19	...	...
I. H. P. per square foot heating surface	.137	.110	...	...

IV.

WIRELESS TELEGRAPHY.

By Lieutenant L. R. de Steiguer, U. S. Navy,
Staff Intelligence Officer.

During the early development of wireless telegraphy it was soon realized that its use would be largely for maritime and military purposes. The electrical engineers and experts then proceeded with this idea in view and have perfected their instruments for communication between ships, between ships and light-houses and stations on shore, and between islands where the laying of a cable is a difficult operation. It is of especial interest to naval officers, owing to the success with which long-distance communication has been maintained over the water, its great possibilities for navigating purposes, and for use on scouting vessels, and its independence of weather, fog, snow, rain, or darkness. Great progress has been made during the last year, mainly in the following points:

1. Tuned and multiplex wireless telegraphy.
2. Increased distance over which messages can be transmitted.

One of the great disadvantages for naval purposes has been that privacy of messages could not be secured, and in the fact that messages could be rendered unintelligible by working another transmitter within the field of the waves. Mr. Marconi claims to have succeeded in tuning his receiving instruments so that they respond only to tuned transmitters. To prove the success of his system, two messages were sent from St. Catherine Point, one in English and one in French. The receivers at Poole were connected to the same air wire, about 40 feet in length, and each rolled out the message on its tape, that in English on one and that in French on the other. While these experiments were being carried out, others for the British Admiralty were taking place between Portsmouth and Portland. These lines of communication intersected each other, but no interference or confusion of messages resulted.

When the German squadron, after its trip out to China, arrived off one of the ports the British admiral there sent a wireless message for a boarding officer to visit the German flagship and offer the usual civilities. Upon the boarding officer's arrival he was informed by the German officers that the message had been read. On another occasion the officers of an English ship were surprised, while experimenting in the Mediterranean, to receive a message in Italian asking as to the position of the ship. This message came from an Italian man-of-war, and its receipt and the interception of the message mentioned above show the importance of tuned instruments for naval purposes. All of these ships were supplied with the older form of wireless apparatus and were unable to preserve secrecy.

Professor Slaby has also presented a method of solving the problem of multiplex and syntonic wireless telegraphy. From the transmitting station he sends out waves of a certain length and arranges the receiving station to respond to waves of these lengths. The receiving wire is made the length of a fourth of a wave length, or an uneven multiple thereof, so that waves of any other length arriving will not affect the receiver, but will be sifted out and travel to earth. By connecting spools of wire to the receiving wire so as to increase the length in multiples of the wave length, as indicated above, it is possible to arrange a station to receive messages from different transmitting stations with the same air wire and with the messages coming from the different stations at the same time. This method would allow the Navy, merchant marine, and the different departments of the Government to have a common system, while any one of these obtains a system of its own by connecting spools of wire to the receiving air wires and thus preserves secrecy in all its communications. Professor Slaby has described his system in a lecture, a translation of which is appended.

During the last year the North German Lloyd Company reported to the German Nautical Society that the captain of the *Kaiser Wilhelm der Grosse* succeeded in communicating with the island of Borkum at a distance of 29 miles, and with a light-ship at a distance of 21 miles. This company, in addition to their stations and ships fitted with the Marconi system, has been experimenting with the Schäfer system, and maintained communication between their stations on shore and the Weser light-ship, in the outer roadstead at Bremerhaven, a distance of 32 miles. These were considered good working distances; but Mr. Marconi has recently succeeded in sending wireless messages from St. Catherine Point to the Lizard, a distance of nearly 200 miles. He has installed an outfit on board the Nantucket light-ship which should be of great benefit to the Navy and merchant marine. Ships arriving can establish communication with New York from 12 to 14 hours before their arrival, and at a distance of over 200 miles. At the request of steamship lines, the English board of trade has instructed the Marconi Company to erect a station on the mainland close to the Fastnet Rock, at the western end of Ireland, for the purpose of reporting the arrival of steamers. Vessels and stations fitted with wireless apparatus have at times rendered great service by sending assistance to ships and people in distress along the coasts. The channel steamer *Princess Clementine*, plying between Dover and Ostend, fitted with Marconi apparatus, has been able, in all kinds of weather, to keep in constant communication with both places on her trips across. Upon one trip, when passing the light-ship, stationed 25 miles off Dunkirk, it was learned that she would be unable to show a light that night unless prompt assistance was sent. The captain sent a message to La Panne, whence it was forwarded to Dunkirk by the regular telegraph line, and a tug was sent to make the necessary repairs. On another occasion this vessel passed a ship wrecked on a bank; she established communication with Ostend, and was able to inform the crew before leaving that assistance was on the way. Experimental stations have been erected on the coast in England to warn vessels, fitted with apparatus, of their approach to dangerous points. The bell connected to the receiving instrument begins to ring when a vessel enters the zone of influence of the shore station, and continues to ring until she passes out of this zone. At the same time she receives the name of the point upon her tape and can establish regular communication with the shore station if she so desires.

CHILE.

It is reported that Chile has made contracts to have stations installed on the Marconi system, reserving the right to terminate the concessions upon six months' notice. By these stations it is the intention to connect Punta Arenas and Ancud or Puerto Montt.

DENMARK.

In Denmark experiments with wireless telegraphy are reported to have been made at Oresund. The distance over which messages were sent was 19.88 miles.

ENGLAND.

During the last year thirty-six ships of the British navy have been equipped with the Marconi apparatus, and ten or twelve more have Captain Jackson's outfits on board. The signal stations at Dover, Culver Cliff, Bill of Portland, Roches Point, Rame Head, Scilly Islands, Gibraltar, and Malta have been equipped or are being equipped with Marconi outfits. The station at Culver Cliff will be placed in communication with the commander-in-chief's office at Portsmouth, and that at Rame Head in touch with the commander-in-chief at Devonport. The principal vessels of the Channel, Mediterranean, and China fleets are now equipped with and using the Marconi system. Good results seem to have been obtained by the vessels of these fleets. Communication has been maintained in many instances over 50 miles, and lately distances of about 100 miles are reported to have been covered. The *Hector*, station ship at Portsmouth, exchanged signals with the *Majestic*, flagship of the Channel squadron, at a distance of 103 miles, and it was thought this distance would have been exceeded if a ship at Portsmouth had not interrupted communication. The Mediterranean fleet has been carrying out experiments in long-distance signaling and the *Tyne*, storeship, is reported to have communicated with headquarters at Malta from Cape Passaro, Sicily, a distance of about 70 miles. Frequently trouble has arisen from atmospheric electricity and from the fact that several vessels have been working their transmitters at the same time, where the waves have interfered with each other, which has rendered the messages unintelligible. When the *Ophir* was conveying His Royal Highness the Duke of Cornwall and York through the Mediterranean, the fleet made an effort to keep the *Ophir* in communication with Gibraltar and Malta and to connect with Crete in passing after leaving Malta. The Press reported the following disposition of ships for that purpose:

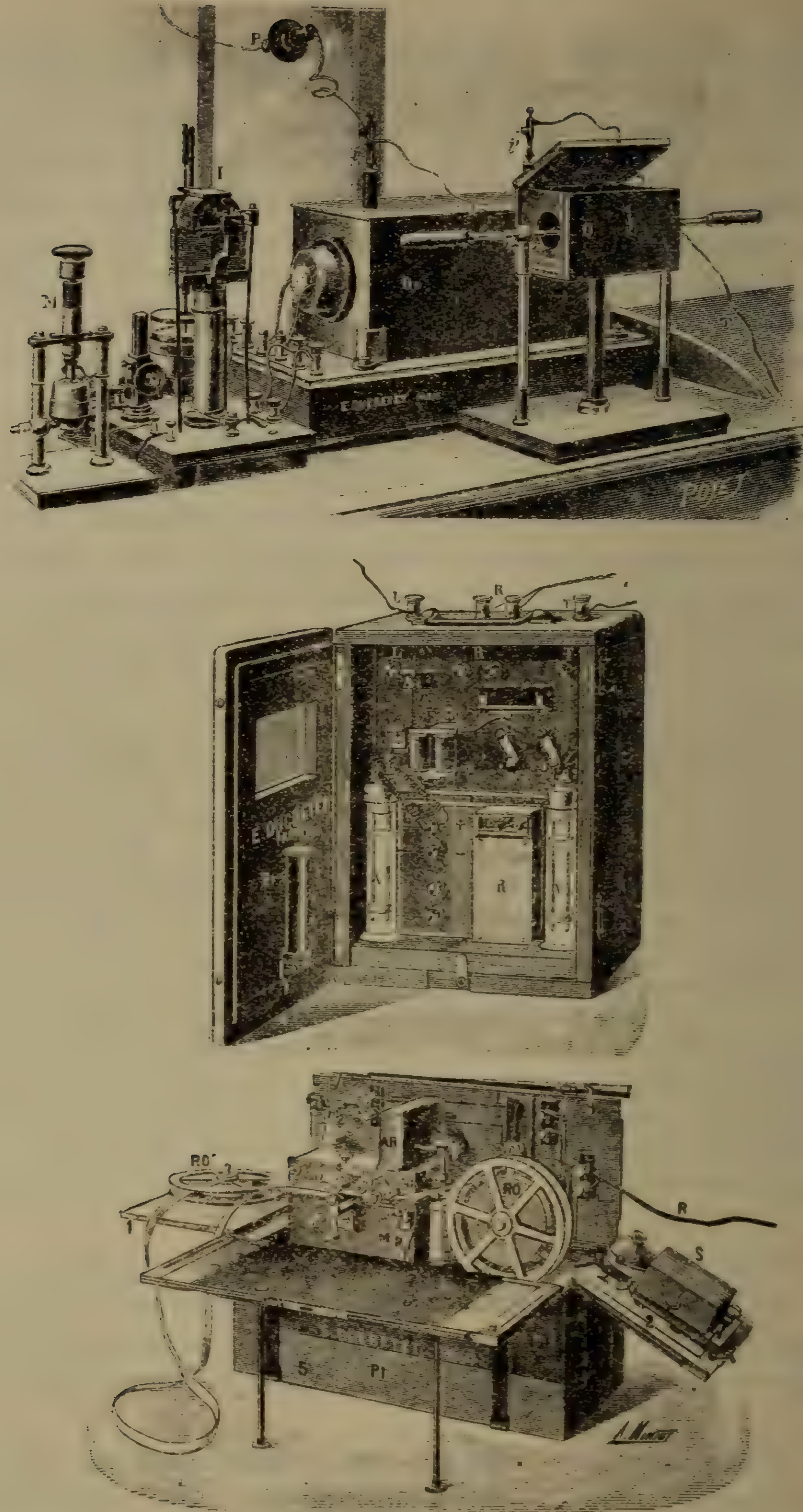
> The *Speedy* on March 20 will proceed from Malta to a telegraph station halfway between Malta and Gibraltar and communicate with the royal squadron by wireless telegraph as it passes; and the *Speedy* will afterwards proceed to wireless distance of the *Tyne* and convey messages to and from Malta to the royal squadron. The *Tyne* is to be 130 miles from Malta at 8 a. m. on March 24 and lay in the track of the royal squadron to communicate messages, through the *Speedy* and *Andromeda*, to the *Ophir*. The *Tyne* will close Malta when she herself gets within wireless distance of the *Andromeda* and return to Sliema moorings. She will afterwards proceed to a point 130 miles from Malta on the track to Port Said, to communicate telegrams to the royal squadron after passing that point on its way from Malta to Port Said.
>
> The *Speedy*, immediately after coaling at Malta, will proceed to Crete and communicate by wireless telegraphy with the royal squadron as it passes in the usual track from Malta to Port Said. The *Speedy*, when the royal squadron is out of wireless distance of the telegraph station in Crete, will proceed with all possible dispatch to Suakim to communicate by wireless telegraphy from that place with the royal squadron as it passes.

The reports coming from the use of wireless telegraphy by the vessels accompanying the *Ophir* were that communication was lost at times and sometimes was only partial, while messages were mixed and rendered unintelligible when more than one transmitter was worked at a time.

The Admiralty has now ordered that wireless outfits be placed on board all battleships and cruisers attached to home ports and the Mediterranean fleet and on all vessels fitted out for the reserve, training, and Channel squadrons. As the Admiralty has the use of Marconi's improvements, all vessels will probably be fitted with tuned instruments.

FRANCE.

In France the Popoff-Ducretet apparatus has been used on board ships of the Mediterranean and northern squadrons and at light-



POPOFF-DUCRETET APPARATUS.

The above cuts show the transmitting, receiving, and Morse automatic recording apparatus, with the connections, arrangement of the batteries, shunts, and boxes, as manufactured by Ducretet. *Bo* is the Ruhmkorff coils, *I* the vibrating interrupter, *M* the hand manipulator, *O* the oscillator, *Br* the coherer, *Br′* a metallic tube, *F* the automatic tapper (Popoff system), *R* the relay, *RO* the roll of tape, *S* the sounder, and *PI* the apartment for the batteries in the Morse recording apparatus.

houses. Communication has been successfully maintained between ships and between ships and light-houses over distances of 45 to 50 miles. Lieutenant Tissot and M. Rochefort have made great progress in developing wireless telegraphy for use in the navy and have made many improvements in the apparatus.

GERMANY.

The Slaby-Arco system has been adopted for the German navy. Professor Slaby has worked with the object of giving the navy an efficient and reliable system, and a less expensive one than the Marconi. The results of his experiments have been very interesting and very successful in solving the question of syntonic and multiplex telegraphy. Some of the vessels have already been supplied with outfits. Light-houses have also been equipped and shore stations installed, which have been found very useful for pilots and for navigation.

ITALY.

In addition to experiments carried on by Mr. Marconi on board ships, the Italian Government has been investigating the project of connecting its outlying islands with the mainland by wireless telegraphy, with the object of substituting this system for submarine cables.

JAPAN.

Japan has ordered outfits for some of her men-of-war, and has also been carrying on experiments on shore for its use in the army. She recently ordered very powerful induction coils in New York for two of her ships, with which she expected to obtain very good results in long-distance signaling.

RUSSIA.

Russia has been very active in carrying on experiments in wireless telegraphy and in equipping her ships and stations on shore. In November of last year it was reported that 200 complete Popoff instruments had been sent to Vladivostock and Port Arthur, for use at these two harbors, stations along the Korean coast, and for the vessels in Chinese waters. Mr. Popoff has been very successful in the development of the coherer, and his system has been adopted for Government service. When the *General Admiral Apraxine* was ashore on the coast of the island of Hohland, in the Gulf of Finland, Mr. Popoff was intrusted with the work of installing two wireless telegraphy stations, one on the island of Hohland and one upon one of the islands in the neighborhood of Kotka, 29 miles distant. It was very important for the work of salvage to keep communication between the ship, the mainland, and the ice breaker *Ermack*. The above stations were completed in January and were continued in use until

April, when the ship was saved. During a period of eighty-four days 440 telegrams were exchanged; the longest consisted of 108 words. The masts were 157 feet in height and that at Kotka was in the midst of a wood. The temperature ranged from 10° F. to −4° F. During snowstorms and in all kinds of weather regular communication was maintained, with the exception of two days when some of the apparatus had been carried away. Soon after these stations had been erected 27 fishermen were carried off on an ice floe. A message to this effect was transmitted from Hohland and was received by the *Ermack* in time to rescue them. One of the Russian infantry regiments experimented with the Popoff system during field maneuvers and obtained very good results. The great drawback experienced in this case was the weight of the apparatus, but it was thought possible to make great improvements by using lighter materials.

SPAIN.

Wireless telegraphy has been receiving some attention in Spain. Experiments are being carried on with a system invented by Colonel Cervera, of the Spanish engineers, with the object of connecting her African possessions and the Balearic Islands with the mainland.

SWEDEN.

Experiments with wireless telegraphy for use in the navy were made last summer and fall in the Stockholm Archipelago between launches and stations on shore. The height of the receiving wire on the launches could not be made more that 78.74 feet; but, notwithstanding this short length, messages were sent 18.64 miles, with a voltage of 16 in the primary of the induction coil, and with islands intervening. A Siemens and Halske apparatus was used, the coherer differing somewhat from that previously used, inasmuch as the tube inclosing the metal filings was made of ebony in place of glass, besides which the distance between the pole pieces could be regulated by means of a screw. According to later reports the Swedish admiralty has contracted for four outfits for shore stations and for apparatus for several vessels of the navy on the Slaby-Arco system.

SLABY-ARCO APPARATUS.

Of the exhibits of wireless telegraphy at the Paris Exposition, the most interesting to the service were the Slaby-Arco and Popoff-Ducretet, owing to their use in the German and French navies. In the Slaby-Arco system the usual vertical air-wire is replaced by a vertical cage. The connections of the transmitter are shown in fig. 1, where J is a 40 or 50 centimeter induction coil with a mercury turbine contact breaker, connected to a direct current supply. If alternating current is available, the induction coil may be connected to it and the contact breaker dispensed with. A condenser, C, is charged from the secondary of the induction coil and discharges itself through the spark gap F and to earth through E_2. The receiver is shown in fig. 2, where S is the air cage, R the relay, F the coherer, and B the battery. When the resistance of the coherer has been reduced by the Hertzian waves, the battery circuit is completed and works the relay and Morse instrument. The advantages claimed for this arrangement are practical serviceability, prevention of danger from high pressure, reduction of atmospheric disturbances, and improvements in the automatic interruption of the coherer circuit.

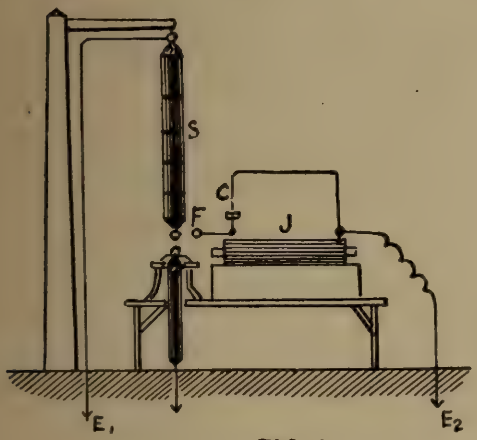


FIG. 1

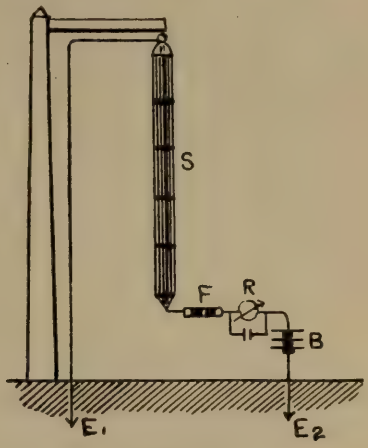


FIG. 2

MARCONI APPARATUS.

To render a station available for transmitting and receiving signals with one air wire, Mr. Marconi has used the key shown in fig. 1. *a* is the battery, *c* the induction coil, *e* the balls of the oscillator, *u* the air wire, *d* the resistance coils inserted between *c* and *e*, and M the

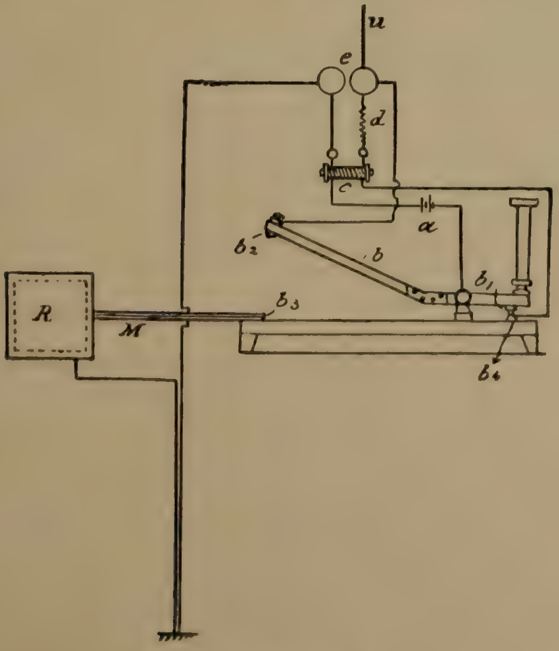


Fig. 1.

receiving apparatus, including the coherer and relays for working the recording instruments. The key has two contacts, b^1 and b^2, insulated from each other. The figure shows the key in the position to emit waves. b^1 in touching b^4 closes the circuit of the battery through the primary of the induction coil *c*. When the key is left to its own weight, the long arm falls and brings together b^2 and b^3, the latter being connected to the receiver through the wire M. The space between b^2 and b^3 must be large to prevent sparking, and the wire connecting the receiver with the key should be inclosed in a metal tube to be protected against the action of the local transmitter.

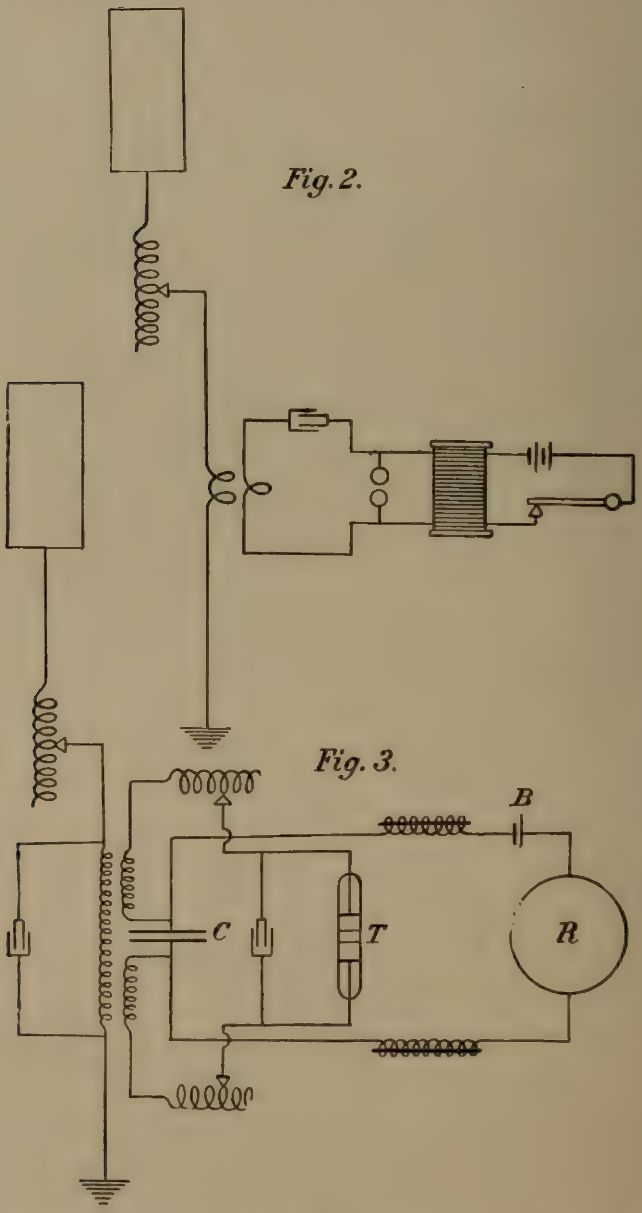


Fig. 2.

Fig. 3.

On April 7, 1901, the patents upon the wireless apparatus shown in figs. 2 and 3 were issued to the Marconi Company. In this arrangement two aerial conductors are used at each station and it is described as wireless apparatus intended to cooperate selectively. Tesla transformers are used to furnish, and perhaps also to receive, the signaling oscillatory impulses, one end of one winding of the transformer being connected to a vertical conductor and the other end to earth. The transformer circuits are tuned, so that they have similar (or harmonic) oscillatory periods, one of the circuits of each transformer forming a persistent oscillator and the other a good radiator or absorber of electrical oscillations. It will be seen in the receiving apparatus (fig. 3) that the secondary is broken in the middle or wound in two parts, the inner ends being connected to a condenser (C) and the local battery circuit, which includes the relay working the receiving instrument (R), while the outer ends are connected to the coherer (T). The vertical conductor is connected to earth through the primary of the transformer.

In the transmitting apparatus, the period of oscillations of the vertical conductor can be increased by introducing turns, or decreased by diminishing their number, or by introducing a condenser in the series with it. The condenser in the primary circuit is constructed in such a manner as to render it possible to vary its capacity. Mr. Marconi has stated that he found that when using coils in which the secondary winding consists of one layer only, best results are obtained when the length of the secondary winding is approximately equal to the length of the aerial conductor at the transmitting station.

AUTOMATIC REPEATERS.

To transmit messages over great distances, Mr. E. Guarini has introduced automatic repeaters, whose duty consists in receiving and, at the same time, sending on the message to the next station. In the experiments signals were sent from Brussels, received at Malines, and retransmitted to Antwerp. The accompanying cuts, taken from the *Kriegstechnische Zeitschrift*, show the construction of a repeating station.

In this arrangement the primary wire of the induction coil B is connected with one pole of battery S. A wave arriving renders the coherer conductive, the current of element P is thereby closed and the relay R is made to function. The primary current of the induction coil B and the circuits of the relay tapper F and of the commutator E are closed, and the spark generator O is made to function. When the relay tapper strikes against the coherer, the current of battery P is interrupted. The button *b* of the relay leaves the contact *c*′, the commutator and the spark generator O cease functioning until a new wave arrives, and so on. The electro-magnet E has been thrown into action and attracted *c*″, whereby the connection between the air-wire and the coherer has been interrupted; but this does not happen until after the filings of the coherer have accomplished their work, and it ceases as soon as the filings become decohered; for the three devices R, F, and E are well regulated, and the activity of F causes that of R and E to cease.

The above apparatus may be used as a transmitter, receiver, simple repeater, and recording repeater. In these cases the presence of an operator is required to operate key M introduced for that purpose. In addition, a plug switchboard C, a Morse receiver *m*, and a connecting plate *p* would also become necessary (Fig. 2). From fig. 2 the manner of performing the above operations can be seen.

1. As transmitter, when the plug in the switch board C is placed in hole f' and the key M depressed in long and short movements corresponding to the Morse signals;
2. As receiver, when the plug is in hole f^3;
3. As repeater, when the plug is placed in hole f' and the key M depressed continuously;

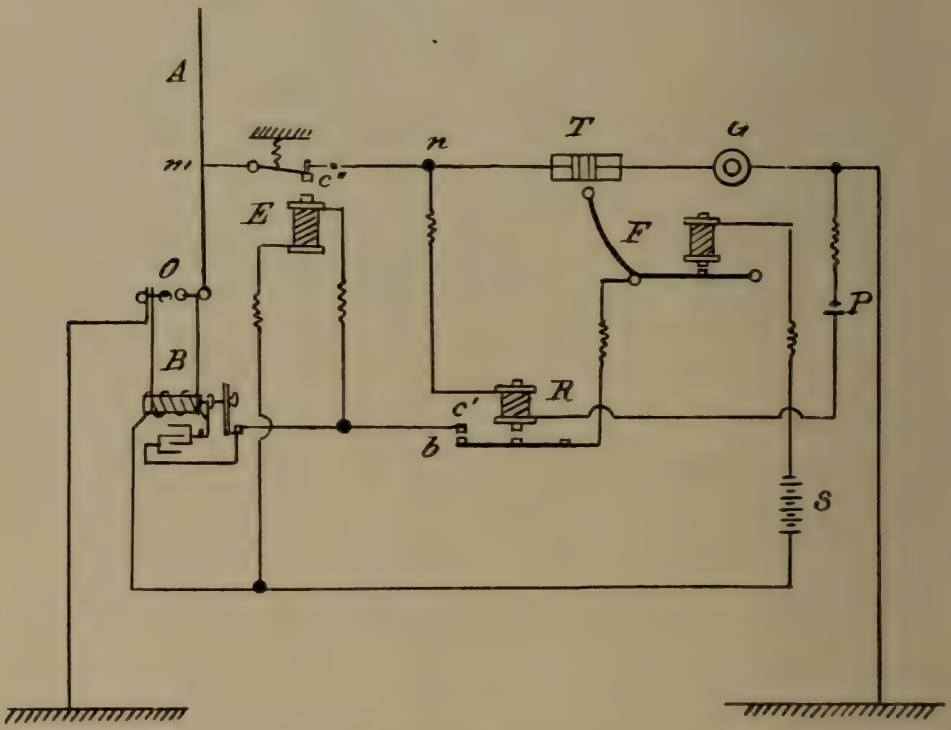


Fig. 1. (For reference letters see Fig. 2)

4. As recording repeater, when the plug is put in hole f^2.

The *Electrician* of March 22 contains a description of Guarini's latest experiments in this line. Fig. 3 shows the arrangement of the repeating station, and is described as follows:

The repeating apparatus included one air-wire, serving equally for the transmitter and receiver. Two relays were employed, as seen in the diagram. The relay in the coherer circuit was extremely sensitive, the distance between the contacts being but a fraction of a millimeter, and the maximum current it could carry through the secondary terminals was 0.4 ampère at 30 volts. On the other hand, for working a 25 cm. spark coil (1 cm. spark gap was employed in the actual experiment) 3 ampères were necessary. The same relay which closed the induction-coil circuit broke the connection between the air-wire and coherer. Instead of connecting the air-wire directly to the coherer, however, it was connected to earth through the primary of a small transformer with a glass core. A condenser was added in series with the secondary of this transformer, the circuit being completed by the coherer, and the usual coherer, choking coil, relay, and battery circuit was made up as in the diagram.

The coherer was inclosed in a metal box, and a self-induction coil, surrounded with crumpled tin and placed in a second metal box, protected one of the connecting wires to the coil of the second relay. The other end of this relay coil, as well as the metal boxes and crumpled tin, were earthed. This second relay was placed outside of the metal box. Its tongue was divided into three parts by ebonite plates. One part opened and closed the circuit of the induction coil; the second constituted the armature of the coil, and the third served to break and close the connection between the air wire and the coherer-transformer according as the coil circuit was closed or open. The latter portion was again subdivided, so that the break occurred at three contacts, in series, instead of by a single spark. The terminal pillar and the wire connecting the relay contact and the coherer-transformer were insulated and surrounded by an earthed iron pipe. A relay of the Siemens type was employed, with the modification that the north pole was connected to the cores, while the south pole was insulated from the armature. One-twentieth of a milliampère sufficed to work it.

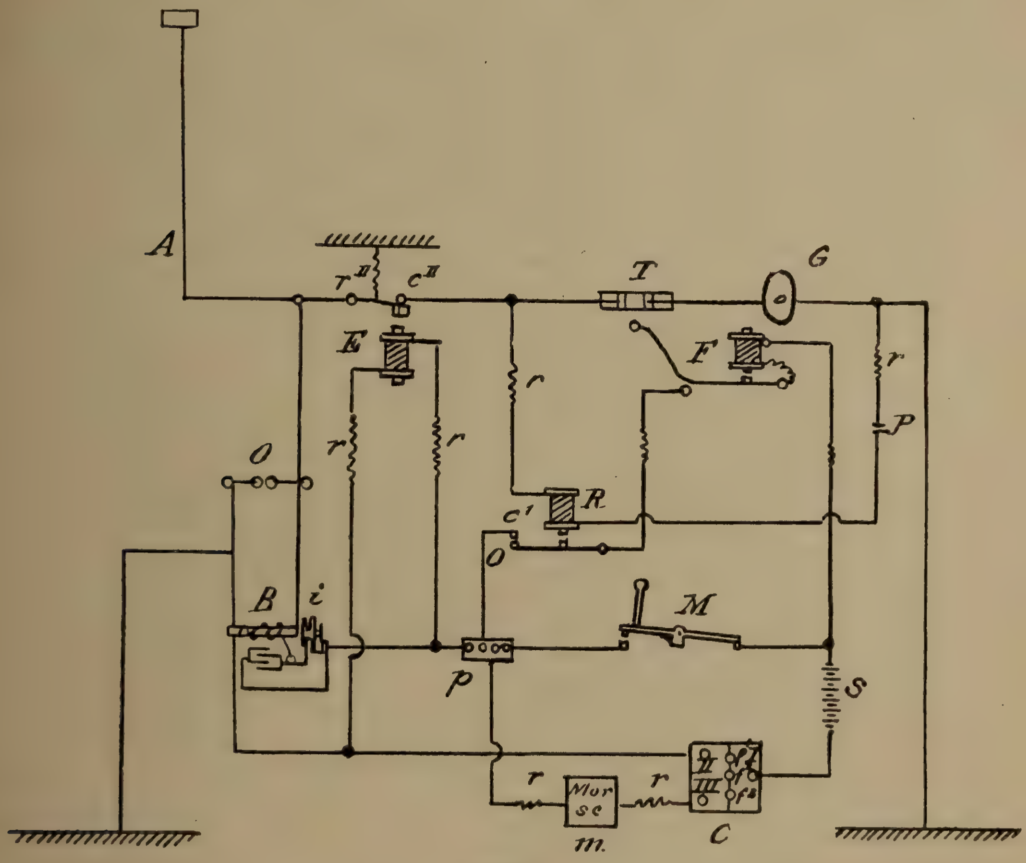


FIG. 2.

A Feeler.
B Induction coil.
i Interrupter.
c Switchboard.
p Connecting plate.

M Key.
P Galvanic element.
S Source of electric power.
E Commutator.
T Coherer.

G Galvanometer.
F Relay tapper.
R Relay.
r Resistances.
o Spark generator.

M. Guarini had also constructed a special form of coherer. The gap between its electrodes was 1 mm., and was completely filled with coarse nickel filings with traces of silver. A vacuum was employed, as usual. As it is easier to decohere the coherer the smaller the current passing through it, M. Guarini introduced a resistance in connection with the tapper relay, so that as the tapper is about to strike the tube a supplementary resistance of 2,000 ohms is introduced in the coherer circuit.

The repeater worked successfully in laboratory experiments, even when the air-wire was connected to the coherer through the intermediary of the armature of an electro-magnetic interrupter, whose object was to break automatically the connection between the coherer and the air-wire when the latter was employed for radiating. But when used for long-distance experiments the repeater at Malines continued to work by itself. As great precautions had been taken to prevent the sparks from influencing the coherer, it was attributed to atmos-

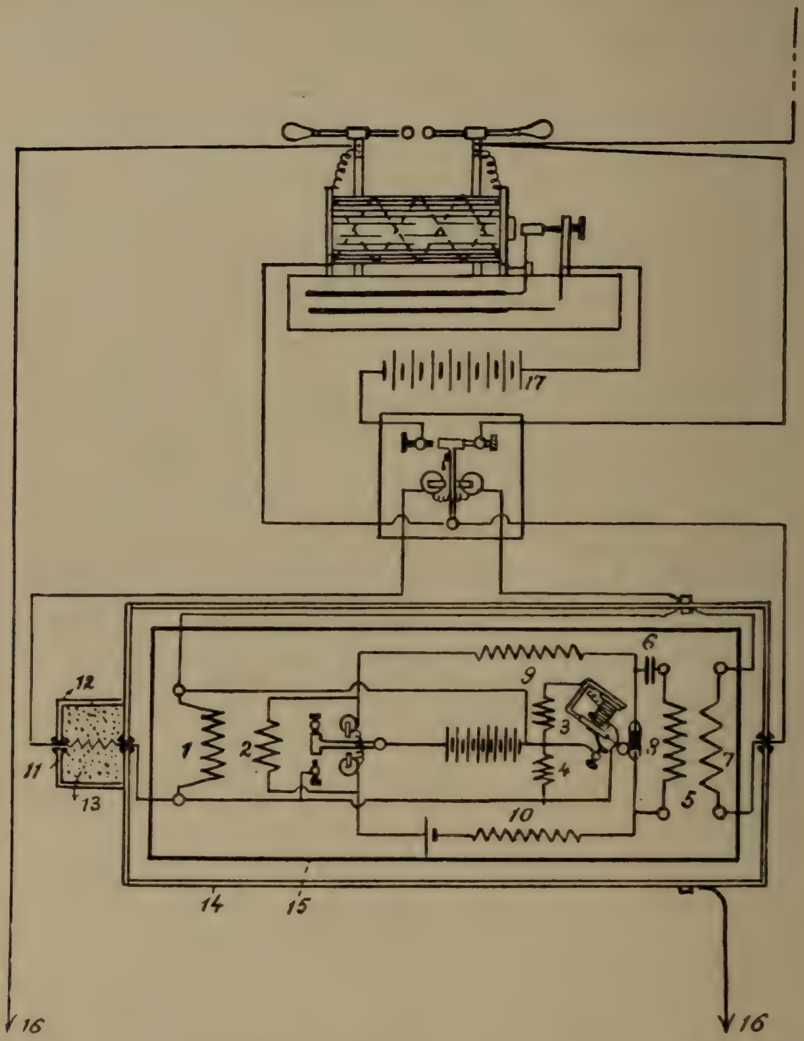


Fig. 3. Guarini repeater connections.

1, 2, 3, 4. Shunts.
5. Transformer.
6. Condenser.
7. 0.25 ohm.
8. 11,000 ohms.
9, 10, 11. Self-induction coils, 40 ohms and 36 henries.
12. Iron box.
13. Crumpled tin in connection with box and earth.
14. Iron box.
15. Board on which the apparatus is mounted.
16. Earth connection (gas pipe).
17. Accumulators.

pheric electricity, which Lieutenant Poncelet proved to be true by experiments. Finally a condenser was placed in parallel with the coherer (fig. 4), and it worked successfully. This arrangement was then adopted for the repeater.

M. Guarini reported that before removing the air-wires of the above three stations he made experiments on the employment of alternating currents. The air-wire on the tower at Antwerp had been carried away by a gale and hung in bends and kinks, making very unfavorable conditions. The signals transmitted by the oscillator were not received at Malines, but all signals transmitted, using alternating currents, reached the relay station at Malines and were sent on to Brussels. At Malines the repeater includes the oscillator, but between the balls there is a gap of only 1 mm. A condenser is put in parallel with the two balls, as in fig. 5, allowing the spark gap to be diminished and reducing the travel of the armature of the electro-magnetic interrupter.

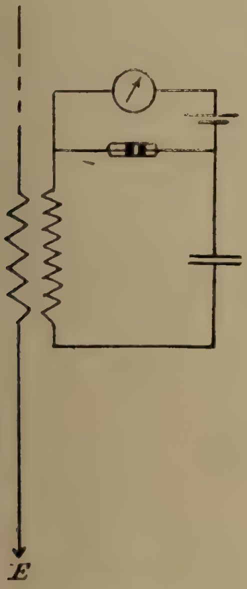


Fig. 4

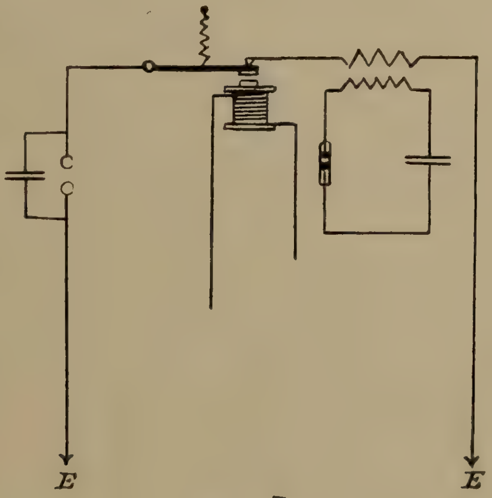


Fig. 5.

TUNED AND MULTIPLE SPARK TELEGRAPHY.

[A lecture delivered on December 22, 1900, in the lecture room of the General Electric Company at Berlin, by A. SLABY, professor at the Technical High School.—Translation.]

Spark telegraphy has recently found practical application for different purposes. The navy was the first to become convinced of the advantages which this system of telegraphy offers, and many of the war ships of England, France, Russia, and Germany have already been equipped with the new apparatus. The enormous sums which the English Marconi Company demanded for the use of its devices (it was a question of several millions for each country) rendered it difficult for the sea powers, with the exception of England, to acquire Marconi's invention. This circumstance was a spur to electricians in other countries to endeavor to arrive at a practical system of telegraphy by means of electric waves, the possibility of which had been demonstrated, by other technical means.

A desire on my part to make spark telegraphy available for our Navy also induced me to work out another system. Together with my then assistant, Count Arco, I succeeded in finding a new method, concerning which I made a report to the Society of Naval Architects at its first session a year ago. This method was perfected technically by the General Electric Company, and was finally introduced in the German navy. For about a year it has been in operation on board a number of German war ships, and I am told that it has proved entirely satisfactory.

But as I stated in my lecture a year ago, our common studies had resulted in a disappointment, at least as far as I was concerned. We had not succeeded in finding anything better; at best we could only show results similar to those of Marconi. We had to consider our principal endeavor, which was to effect a tuning between corresponding apparatus so as to render it possible to telegraph in all directions without interference, a failure; and I must confess that only a year ago I expressed myself somewhat skeptically as to the possibility of succeeding in such an endeavor. But spark telegraphy does not let go of those who have once come under its magic spell. In spite of the former disappointment I resumed the study during the summer of the present year, this time with better success. I found a few new phases which brought the possibility of reliable tuning very near. Privy Councilor Rathenau was kind enough to have the new methods tested with the resources of the cable work *Oberspree*, under the competent and ingenious supervision of Count Arco. What we are able to show to-day is the result of work on which we engaged together early in October, in which Count Arco, however, has had the greater share, having overcome numerous technical difficulties.

Spark telegraphy is as yet the darkest and most difficult chapter of electro-technics, especially when it comes to following the processes by measurements and computations. But I will try, by reference to analogous mechanical ideas to illustrate the manner in which the problem was solved.

We owe the scientific principles of spark telegraphy[1] to a German scientist, Heinrich Hertz, whose all too early death has been a great loss to science. His researches moved in a sphere far remote from the possibility of practical application. To him it was a question of gaining enlightenment on fundamental conceptions as to the nature of electric phenomena. If we are to-day permitted to harvest the fruit of his labor, let us acknowledge this circumstance with a profound sense of gratitude, and let us, in our turn, make a stand against those who value science only in so far as it brings immediate returns.

Hertz ascertained that a spark upon meeting a rectilinear wire causes in it electric vibrations, which are propagated through space in regular wave motion with the rapidity of light, and that in their turn they produce in other conductors which they meet on their way electric phenomena, accompanied by the formation of sparks. Since then we have found means for increasing these effects to such a degree that they can be discerned without the scientist's lenses. An experiment will illustrate this. Into a wire stretched across here I will conduct the vibrations of a spark excited by a small Ruhmkorff coil. From a second wire stretched parallel to the first at a distance of 1 meter, and having not the least metallic connection with it, we can draw sparks 4 to 5 cm. long. In the dark we shall see that both wires are equally luminous. The strict law upon which this phenomenon is based has been clearly explained by Hertz. The technologist has done nothing but find the means for materially increasing this effect.

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[1] The electric spark is the characteristic feature of the new system of telegraphy. So far it has not been possible to create, by anything but the spark, electric oscillations of the magnitude required. The term "spark telegraphy," therefore, appears entirely proper. The term "wave telegraphy," which has also been suggested, is unscientific and not descriptive of the nature of the matter, since every system of telegraphy, and telephony as well, is based on electric waves.

The electric phenomenon in these wires is one of oscillation. The electric voltage we have noticed is an alternating voltage which pulsates five million times a second between its maximum positive and negative values. Alternating voltages of such enormous frequency are harmless to the human body. They rebound ineffectually from the sluggish nerves. If they pulsated a few hundred thousand times more slowly, I should not have dared the contact.

But the alternating voltages are not distributed equally over the whole length of the wire. In order to render them visible, I have caused them to affect sensitive plates. The developed picture shows plainly an increased effect from the spark gap to the free end of the wire.

This fact suggests an examination of an analogous mechanical phenomenon. If we fasten one end of a straight steel wire in a vise and cause the free end to vibrate, oscillations of a similar character will take place. The vertical distance to which the oscillations extend, called amplitudes, are greatest at the free end. Exactly the same thing occurs here, if we consider electric alternating voltages analogous to these mechanical amplitudes. The transmission, also, of the effect to a second wire by wave motion may be illustrated by this mechanical process. If I bend a steel wire at a right angle, with sides of equal length, and make the angle fast, every vibration of one end of the wire will be transmitted to the other. The vibrations pass through the fixed point, which thus becomes the node of the oscillations, while the point where the extent of the oscillations is greatest is a potential loop.

In order to make the experiment successful, however, the node of oscillations should not be held absolutely tight, but should admit of slight vibrations. The frequency of the oscillations of the node must be such, however, as to correspond to the oscillations of the steel wire to which the movement is to be transmitted. It is obvious that these conditions are best fulfilled when the two sides are of equal length.

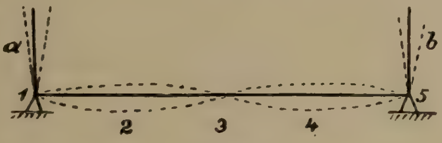

Fig. 1.

The movement transmitted to the second side of the angle can be caused to go on. If we take a steel wire six times as long as the free side of the angle and bend it in two places at right angles, as shown in figure 1, the potential loop 2 will be communicated to the prolongation of the wire and form at 3 another node, and at 4 again a potential loop. From here the movement is finally transmitted through the nodal point 5 to the vertical wire *b*. A short time after we have set *a* to oscillating we shall perceive exactly the same motion at *b*. The transmission takes place by means of so-called stationary waves in the connecting steel wire. The whole length, comprising a wave mountain and a wave valley, is called the wave length. We at once recognize the proper conditions. The length of the wire swinging free must be one-fourth of a wave length.

We find exactly corresponding conditions in the electrical process. The electric oscillations which we produce in a vertical wire *a*, by causing a spark to jump over at the lower end, form at the upper end a potential loop of oscillations, the frequency of which is determined by the length of the wire. These oscillations are communicated to an elastic medium, the ether, which together with the air fills the space. They are propagated through it with the rapidity of light in the form of a wave, the length of which is exactly four times that of the electrically oscillating wire. We can determine it accurately to a centimeter.

If these waves meet another wire *b* at any distance, they cause it in its turn to oscillate electrically. The oscillations will be strongest when the oscillations of the wire itself corresponds to the frequency of the waves; that is, if its length is exactly a fourth of a wave length and when the lower end is a potential node. Both conditions we can always satisfy, since we can control the length of the wire and give to the lower end a zero potential by carrying it into the earth, thus making it a node,

Spark telegraphy would be complete if we had a means for rendering perceptible the alternating voltages produced in the secondary wire.

We shall hardly be able to produce a visible spark by the approach of a metallic object, as we did in the experiment a while ago, because the effect varies inversely as the distance. If at 1 meter (3.28 feet) distance we had a spark 4 cm. (1.57 in.) long, we could, at 100 km. (62.1 miles) distance, at best expect a spark four ten-thousandths of a millimeter long. That would not be sufficient for the strongest glasses. Moreover, the observer would have to take his station on a lofty seat at the top of the wire.

To establish the presence of such infinitesimal voltages other means must be resorted to. The most sensitive of these is the Branly tube. It is filled with metal filings and offers, when the filings are thrown in loosely, an extremely high resistance to an electric current. But when exposed to an electric voltage, infinitesimal sparks, invisible to the naked eye, jump from one particle of the filings to the next and, by condensation of the metal vapors, form bridges, so that the electric current can pass through the tube. The slightest vibration causes the bridges to fall down and at once restores the high resistance. With the ends of the tube a galvanic element is connected, and into the circuit thus formed is introduced an electric signaling apparatus. When one end of the tube is exposed to an electric voltage the circuit closes in the manner indicated and the signaling apparatus makes a visible or audible signal. We will call this tube a "fritter," since in technology the partial fusing together of loose substances is designated as a fritting process.

The question now arises, To which part of the receiving wire shall we connect the fritter (coherer)? Obviously where the alternating voltage is a maximum. If we connect the lower end of the receiving wire to earth, a node of electric voltage will be formed there, as previously shown, so that the effects can be but very small. It would be best to make the connection at the top; but that is precluded by the inaccessibility of that point.

Hitherto the following method has been invariably pursued: The receiving wire was suspended insulated. To its lower end was secured the fritter, the other pole of which was connected to earth. Measurements have shown that the capacity of the fritter is so great that the lower end of the wire may be considered practically a node for the electric oscillations received by the air-wire. No noteworthy voltages can form there. But as the effect depends exclusively on the voltage affecting the fritter, the usual arrangement is wrong in principle. It does not admit of the utilization of the maximum potentials which occur in the receiving wire. If this arrangement has nevertheless given results, it is due merely to the circumstance that the length of the receiving wire does not always correspond exactly to a fourth of a wave length and that the sending apparatus, outside of the primary waves, sends out also parasitic secondary waves which at the lower end of the receiving wire permit the formation of irregular small voltages. To this circumstance must also be traced the frequently unreliable, apparently capricious behavior which has hitherto marked the receiver. Even though the installation had been carried out systematically according to prevailing ideas, one could not always feel quite sure of success. Thus the essential feature of a technically serviceable apparatus was lacking. The receiver hitherto used resembles a human ear which hears, instead of the pure fundamental tone of an instrument, only incidental secondary sounds and overtones.

But what is the proper arrangement? Our mechanical illustration indicates it clearly. By direct earthing of the receiving wire we must form a reliable potential node and conduct through it the waves received. A wire joined at the nodal point, of the same length as the receiving wire, produces at its free end a potential loop of the same magnitude as that of the free upper end of the wire, but it has the advantage of accessibility. It is not necessary to conduct the prolonging wire in a straight line. It may be wound on one of those large spools of which you see several in this hall. It has thereby become possible to increase to a surprising degree the accuracy and reliability of signaling. This is the quintessence of the invention which I wish to show you to-day.

But this arrangement admits of still more. It renders it possible to utilize as receiving wires for spark telegraphy conductors which already exist, such as lightning rods, flag poles, and iron ships' masts. The telegrams which we shall receive here shortly were collected at the lightning rod on the smokestack of the Electric Central Station, and all we had to do was to lead a wire of a certain length from the earthing point of the lightning rod to our apparatus in this hall. The economic and technical importance of this circumstance is obvious. It opens a wide field for the employment of spark telegraphy in cities.

Until now such general application of the system could not be seriously considered, because there was great imperfection inherent in spark telegraphy as hitherto used. It was not possible to tune two stations in such manner as to enable them to correspond with each other without interference from other stations. All electric waves passing through space infallibly affected every receiving apparatus within their sphere. Privacy of correspondence was therefore impossible. When our war ships, equipped with the older apparatus, were approaching the harbor of Shanghai, they received, several miles off the roadstead, the spark telegrams which the English war ships stationed there were exchanging with each other.

The question of tuning may now be considered solved. According to a communication from Professor Fleming in the Royal Institution, Marconi is said to have solved it; but for the present he wishes to keep the manner of the solution secret.

The solution which we have arrived at is based on the arrangement referred to. I can indicate the quintessence of the matter in a few words. Two corresponding stations work with wave lengths agreed upon, wave lengths being capable of the greatest diversity. I shall explain later by what means we produce them at the sending station. How can a receiving apparatus be arranged so that it will respond only to one kind of waves of a length agreed upon? One method is at once apparent. If we make the receiving wire the length of a fourth of a wave length, or an uneven multiple thereof, all other waves, as to which the earthing point is no potential node, will infallibly travel into the earth. They will not reach the receiving station at all; it has been rendered immune to them. We may also say, to use another figure, that we sift or filter the waves.

This method insures immunity from disturbance and privacy of correspondence with one other station. But simultaneous correspondence with several stations would still remain impossible, for we are confined, as far as the wave length is concerned, to our lightning rod or ship's mast; we can not lengthen or shorten it, as circumstances may require.

A happy property of electric waves has made possible the solution of this problem also. For waves which are exactly four times as long as the receiving wire, the earthing point is a pure potential node, although very insignificant differences of potential are possible and even beneficial, as I have previously demonstrated. If the prolonging wire is exactly of the same length as the receiving wire, all waves of different lengths travel into the earth at the nodal point. But we can force such waves also to travel into the prolonging wire if we make the total length of the wire, that is to say, the receiving wire plus the prolonging wire, equal to one-half the wave length. The earthing point is then no longer a pure node, but allows the waves to pass through almost undiminished, that is, only this special kind of waves and no others. Figures will perhaps render this clearer. If we wish, with a ligthning rod 40 meters (131.2 feet) high, to receive waves whose length is not 4 x 40 or 160 meters (524.9 feet), but, say, 200 meters (656.2 feet), the whole wire length must be 100 meters (328.1 feet); that is to say, we must join to the lightning rod of 40 meters (131.2 feet) another wire length of 60 meters (196.8 feet).

This simple expedient enables us, to quite a considerable extent, to fit a receiving station for the reception of different wave lengths. It will only be necessary to have on hand a sufficient supply of those large spools, and to set up a number of receiving apparatus corresponding to the number of stations with which it is desired to correspond. For the sifting of the waves is accomplished in such a reliable and exact manner that we can receive simultaneously, even with one and the same air wire, telegrams arriving from entirely different directions and distances.

But the engineer is accustomed to work with a coefficient of safety. In this case, also, we have endeavored to insure the reception of signals by increasing the precision and intensifying the effect. This is done by means of a little apparatus of remarkable simplicity, which I may say I came upon accidentally in my studies, but the action of which was a surprise to me. This apparatus, in its simplest form, consists of a coil of a certain form and method of winding depending upon the wave length. It has the property of diminishing the speed of an electric impulse, from which results a material increase of voltage, and I am therefore inclined to call the apparatus, which as far as I know is new, a multiplier. It is not to be confounded with a transformer, for it has no secondary winding. I can explain the effect of the multiplier by analogy to an acoustic process. I have here a tuning fork, which I set to oscillating by striking against it with a hammer. It sounds acoustically, as the air wire sounds electrically, when struck by ether waves. But the tone emitted is weak, and soon dies away. It is deafened to a considerable extent. This is due to the resistance which the oscillating tines of the tuning fork have to overcome. But we possess a means for increasing the oscillations materially, and prolonging their duration; that is the sounding board. If I bring the oscillating tuning fork into contact with it, the sound becomes louder and lasts longer. We transfer the acoustic oscillations to another medium, which possesses less deafening effect and increases the amplitudes of the oscillations.

What the sounding board does for a true Stradivari, the multiplier does for spark telegraphy; it renders the signals stronger and purer.

If we connect such a tuned multiplier coil between the prolongation of the receiving wire and the fritter, we obtain higher voltages at the fritter, thus increasing the certainty of actuation. Besides increasing the intensity, the multiplier also effects another sifting, for it allows only those waves to pass for which it is tuned; all others, either longer or shorter, are reflected by the coil, in case the imperfect potential node at the earthing point has allowed them to pass through. The multiplier coil refuses them admittance, so to speak, to the fritter.

(An experiment introduced demonstrated that a spark of 1 centimeter (.394 inch) length, drawn from a wire filled with electric oscillations, was increased to 10 centimeters (3.94 inches) by the introduction of the multiplier.. The terminal of the multiplier wire showed far visible radiation, which could be made to disappear suddenly by merely approaching a hand to the coil.)

There remains to explain by what means electric waves of definite and agreed length are created at the sending station.

We use for this purpose a modification of the apparatus which I described a year ago and which has since been used in our navy.

The principle from which we started on this point was that spark telegraphy is an electric transmission of power. Aside from the consideration of the degree of effect, the preferable sending station will be that at which the greatest possible electric energy can be converted into the oscillating form. To this effect not only high voltage is expedient, but also a large quantity of electricity. This we generate by using, instead of a single insulated wire, an earthed transmitting loop (fig. 2) which contains a condenser, K, in order to increase the quantity of electricity. Our condenser is in the shape of the well-known Leydon jars. For charging these we use the whole loop closed through the earth, while for the discharging process, which begins with the starting of the spark and creates those electric oscillations which are alone effective for long-distance work, we use only the first vertical conductor KC. To prevent these oscillations from passing into the shunt to earth, we connect at the upper terminal of the conductor a very differently tuned coil, CD, of great electric inertia. I have already demonstrated that such a coil acts as a barrier—as a wall, so to speak—from which the rapid oscillations rebound, that is to say, are reflected. The distance effects can then proceed solely from the first vertical wire and will not be disturbed by possible counter effects of the second vertical conductor DE. The length of the electric waves proceeding from such a transmitter is determined from the length of the wires and the capacity of the condenser. But we can change them at will by the introduction into the circuit of tuned coils, whose inertia effect diminishes the frequency of the oscillations. But to each frequency corresponds an exactly computed wave length.

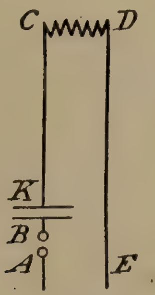

Fig. 2

In how far we have succeeded with the devices described in arriving at undisturbed multiple telegraphy will be seen from the experiment which we are about to conduct.

These two sets of receiving apparatus are connected to one and the same lightning rod on the smokestack of the Electric Central Station *Schiffbauerdamm.* According to hitherto prevailing ideas, this arrangement is the most unfavorable one conceivable. And indeed, there can be no doubt but that a great part of the oscillating energy arriving travels into the smokestack and is conducted to earth and lost. But the small portion which falls upon the top of the lightning rod is quite sufficient to secure reliable signals. From two different transmitting stations telegrams will be sent out simultaneously. One of the stations is in my laboratory in the Technical High School, at Charlottenburg, about 4 kilometers (2.48 miles) distant. The sending wire there is conducted through the window to the top of the pole 16 meters (52.49 feet) high on the roof of the building. The window faces west, so that the great assemblage of High School buildings lies directly in the way of the rays. Only from the short length of wire which is above the roof can electric waves be sent here. The other station is in Schönweide at the cable work *Oberspree,* 14 kilometers (8.7 miles) distant. The sending wire there is suspended between two smokestacks. The electric waves have to pass over Berlin in its greatest extent from southeast to northwest; numerous high smokestacks, spires, and house gables are in the way of the waves and attenuate their intensity.

We will first call up Charlottenburg and correspond with that station alone, then with Schönweide, and finally receive telegrams from both stations simultaneously.

(The experiment showed entirely faultless, simultaneous correspondence at the rate of 72 letters a minute. Below is a photograph (fig. 3) of two telegrams received simultaneously.)

* * * * * * *

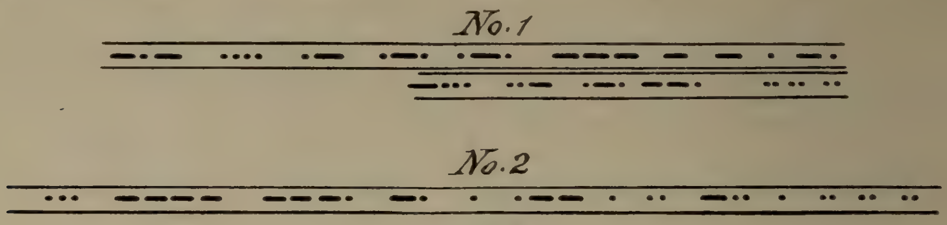

Fig 3

APPENDIX.

Since the delivery of my lecture I have been asked by several colleagues as to the path by which I arrived at the solution stated. Of course it was not through the mechanical analogies of which I made use during the lecture. The solution was found by a purely theoretical method and confirmed by tedious measurements at special experimental apparatus in my laboratory. I shall have to refer a report on these researches to a more opportune time, but in the following I will briefly state the course pursued.

The theory of the transmitter in spark telegraphy leads to the differential equation

$$\mathrm{R}_1 \frac{di}{dt} + \mathrm{L}_1 \frac{d^2i}{dt^2} = \frac{l}{\mathrm{C}_1} \cdot \frac{d^2i}{dx^2},$$

in which R_1, L_1, and C_1 (resistance, self-induction, and capacity) refer to the unit length of the wire, and x represents the distance from the terminal of the same. The solution gives the equations

$$i = \mathrm{A}e^{-\frac{\mathrm{R}}{2\mathrm{L}}t} \cos \frac{2\pi}{\mathrm{T}}t \, . \sin \frac{\pi}{2l}x.$$

$$\mathrm{T} = 4\sqrt{\mathrm{CL}},$$

in which A is a constant; l the length of the wire; R, L, and C are the values applicable to the whole course of oscillations; $\frac{l}{\mathrm{T}}$ is the frequency of the electric oscillations. The result of the term $\sqrt{\mathrm{CL}}$ is the value l when C is applied to electrostatic and L to electro-magnetic measurement, with wires of some length such as will alone be used in practice, and leads to a wave length $\lambda = a$. The difference of potential per unit length of wire will become

$$\frac{dv}{dx} = \mathrm{B}e^{-\frac{\mathrm{R}}{2\mathrm{L}}t} \cos \frac{2\pi}{\mathrm{T}}t \, . \cos \frac{\pi}{2l}x.$$

These formulæ show that the wave lengths created are equal to four times the wire length and that the alternating voltages occurring in the wire follow a simple harmonic law. At the free end of the wire a potential loop is always formed, and at the spark gap a potential node. This I found confirmed when I caused the radiation proceeding from the wire to affect photographic plates in the dark. I placed the plates close behind the wires so that the latter touched the sensitive surfaces. The developed pictures show a regular increase of the voltages toward the free end of the wire and establish the presence of stationary electric oscillations.

But the simple relation between wave length and wire length applies only when the change in the capacity of the wire occasioned by the proximity of the earth is left out of the question. Even a slight slope of the wire toward the earth causes a great alteration in its capacity, and hence material increase of the wave length. For this reason the earthing of the spark gap acquires the utmost importance as far as the transmitter is concerned. These complicated conditions can be fully explained only with the aid of experimental material, which Count Arco has in the meantime collected in great abundance. But for the statements referring to my laboratory researches and short-wire lengths, the above mentioned simple relation may be safely adhered to.

If the radiation proceeding from a rectilinear wire is caused to act upon another parallel wire of equal length, at some distance, there will be excited in the latter also alternating voltages, following the same harmonic law, as soon as the point opposite the spark gap is made a potential node by earth connection. Perfect measurements can be made with a well-adjusted spark micrometer, one pole of which is connected to earth.

If to the secondary wire CD (fig. 4) is joined a prolongation CE, not affected by the induction, of equal dimensions, a free potential node will be formed at C, through which the oscillations will be propagated, producing at E another potential loop of the same magnitude as that at D. An earth connection at C is of no influence in this case.

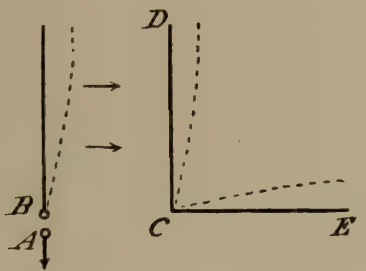

Fig. 4

If the receiving wire is shorter than the inducing quarter wave length, maximum alternating voltages of the same magnitude will be formed at the terminals D and E (fig. 5) of the wire bent at a right angle only when the total length DCE is made equal to one-half wave length. At G, the center of the total length, a free potential node will be formed. An earth connection at C weakens the potential loop at E but slightly.

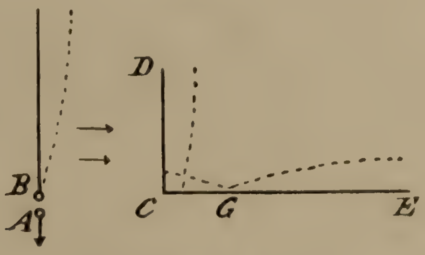

Fig. 5

If the air wire is in the shape of a loop, as in fig. 6, D being connected with H, E and F being free terminals, there will be formed at CD and GH on the one hand,

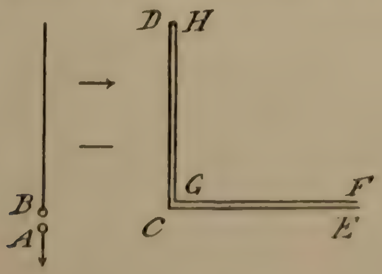

Fig 6.

and at CE and GF on the other hand, exactly similar oscillations, which at D and H, as well as at E and F, have potential loops, and at C and G potential nodes.

A spark micrometer placed in the circuit between E and F shows no voltage; hence there is no difference of phase between these two points. But if another piece of wire EJ (fig. 7), equal to half a wave length, is joined at E, there will occur between E and J a shifting of phase of 180°. The spark micrometer introduced into the circuit between J and F will excite sparks almost twice as long as at the connection between F and earth.

The practical application to be drawn for the receiver of spark telegraphy from this and numerous other experiments is obvious. In my lecture I have attempted to show this by an analogous mechanical example: That in the usual arrangement, where the lower end of the insulated receiving wire is connected with the fritter, a potential node is actually formed is apparent from the fact that the fritter, as measurements have shown, possesses a great capacity toward earth—almost one microfarad.

The arrangement sketched in fig. 7 renders it possible to conduct to the fritter directly the double voltage and at the same time to make it entirely earth free. Another valuable property of this arrangement consists in the fact that the fritter becomes independent of the static charges of the atmosphere. Anyone who has made practical experiments with spark telegraphy must be aware of the intolerably frequent disturbances due to atmospheric electricity.

In our experiment on December 22, Count Arco had still further simplified the arrangement materially by a happy inspiration. Instead of the double wire a single wire DCE (see fig. 7) had been conducted to the apparatus at Schönweide, and the fritter applied between points E and J. The effect was exactly the same. The apparatus received telegrams without any earth connection, which circumstance refutes once for all the still prevailing opinion that in spark telegraphy transmission through the earth plays a considerable part.

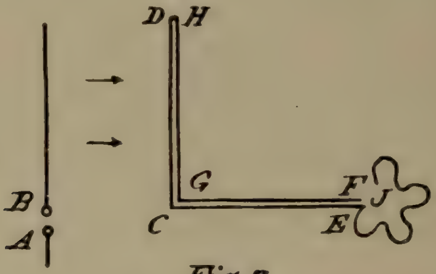

Fig. 7

The intensifying effect of the multiplier I discovered accidentally one day when I wound the prolonging wire EJ (fig. 7) in the shape of a coil in order to make it easier to handle. The remarkable increase of voltage which I ascertained on this occasion caused me to study more closely the interdependence between this effect and the shape of the coil and method of winding.

The theory of the multiplier is not quite simple. In my opinion its action is based on the fact that in the windings of the coil a shifting of phase takes place in such manner that for certain windings the direction of the mutual induction is reversed.

In the tedious laboratory measurements and micrometer readings, my assistant, Engineer Seibt, has been a great help to me by his perseverance and care.

As to the question frequently asked concerning the maximum distances over which we expect to be able to telegraph with this new system, I can say at present only that I do not know. But in spark telegraphy two things should be carefully kept apart: The reliability of constant operation in the hands of ignorant officials, no matter how faithful and conscientious, and an isolated record experiment by engineers who are entirely familiar with the most intimate processes going on in the different apparatus and who make use of every available means for increasing their action and sensitiveness. The former problem is by far the more difficult to solve, and we have therefore taken it in hand first. A statement as to the distances attainable will soon follow, since the secretary of state for the imperial marine office has made available for experiments such warships as may be required for that purpose.

SYNTONIC WIRELESS TELEGRAPHY.[1]

By Guglielmo Marconi.

The very rapid advances which have been made in the art of telegraphy through space continues to attract much attention to this fascinating subject. What was stated yesterday to be impossible has now become possible, and what we regard as almost insurmountable difficulties may be removed in the immediate future. The number of experimenters working in this field has increased, as many workers who, some time ago, had little or no faith in the practical utility of wireless telegraphy have now changed their minds and are taking up the subject. I believe it to be necessary, before I proceed to deal with the subject, to state that in my opinion a large amount of inaccurate and misleading information is being from time to time published upon it in the daily and even in the scientific press. I shall endeavor to correct some of the misstatements which have been made.

As the title of my paper implies, it is my intention first to describe fully the efforts I have made in order to tune or syntonise the wireless system, efforts which I am glad to say have been crowned with complete success. I also wish to mention something of the difficulties encountered in promptly publishing the results (whether successful or otherwise) obtained in the course of my experiments. A commercial concern, such as the one with which I am working, does not exist solely for the advancement of science, but especially for the purpose of securing a pecuniary return to those who have braved risks and undertaken sacrifices in assisting and forwarding the necessary experimental work. It is often considered possible that certain new methods and results may, if prematurely published before being fully patented, be utilized by persons whom I might call business rivals, thus preventing those who have borne the initial cost of the first tests from benefiting in a fair measure. I am, therefore, frequently prevented from promptly publishing the methods by which I have obtained interesting results. By quoting the dates of the British patent specifications and other publications, I hope to be able to establish, to a certain extent, the dates at which the various systems or methods were worked out. It may probably surprise some of you when I mention how comparatively long ago some of the patents which I shall discuss to-night were applied for and perfected.

Last winter I had the honor of describing before the Royal Institution of Great Britain most of the successes obtained up to that date in communicating by means of my system from one place to another. It is my desire in this paper to give a description of the further progress made, with special reference to the results obtained by tuning or syntonising the installations. So long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilization of the system was imposed. With simple vertical wires, as shown in fig. 1A and fig. 2, connected directly to the coherer and spark gap at the receiver and transmitter, as used by myself before 1898, no really satisfactory tuning was possible. It was, however, possible to obtain a certain selection of signals if various stations in the vicinity used vertical wires differing very considerably in length. Thus two stations communicating over a distance of, say, 5 miles and using wires 100 feet long would not interfere with the signals transmitted by the other two stations, say 2 miles from the first, which were using aerials only 20 feet long and communicating over a distance of about 1 mile. The new methods of connection which I adopted in 1898, i. e. (see fig. 8), connecting the receiving aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser, so as to form a resonator tuned to respond best to waves given out by a given length of aerial wire, were important steps in the right direction. I referred extensively to this improvement in the discourse delivered before the Royal Institution on February 2, 1900, and my first British patent specification referring thereto was applied for on June 1, 1898, No. 12326, and published in due course. This mode of connection was also discussed by the technical press.

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[1] Paper read before the Society of Arts, May 15.

It is remarkable that eminent scientists and engineers, such as Professor Slaby and G. Kapp, who have been good enough to discuss my work on wireless telegraphy, should be so badly informed on the subject in general as not to know that this method and many other improvements on my original system have been in use by myself and my assistants for several years. I wish to give you an illustration of what I mean. In a paper on "Tuned or multiple wireless telegraphy," by Professor Slaby, of Charlottenburg, read on December 22, 1900, and published in a special number of the *Elektrotechnische Zeitschrift*, he stated: "Up to the present the following method has been followed without exception: The receiving wire was *suspended insulated and attached at the lower end to the coherer*, the other pole of which was connected to earth."

Again, G. Kapp, in an editorial review in the same publication, states: "According to the Slaby-d'Arco system and *in opposition to the Marconi system the receiving wire is earthed*." The inaccuracy of these statements is very apparent if we compare them with the description given by myself nearly three years previously in the British patent applied for, as I have remarked, on June 1, 1898, published in July, 1899, and openly discussed by the scientific press of this and other countries a long time previous to the date of Slaby's paper. At line 7, page 1, of my description, will be found the following passage: "According to this invention the conductor (aerial) *is no longer insulated, but is connected to earth* through the primary of an induction coil, while the ends of the imperfect contact (or coherer) are connected to the ends of the secondary one of the connections passing through a condenser." As you will notice, nothing is said in this patent of the necessity of insulating the vertical wire of the receiver. If the system described here had not been used by me I very much doubt whether we should have succeeded in maintaining communication with the East Goodwin lightship during 1899; in maintaining communication across the English Channel that same year during the meeting of the British association at Dover, and in supplying the admiralty in the course of the year 1900 with 32 installations, all of which passed an official 100-kilometer test (most of the distance being overland) at the rate of about three installations per week.

Leaving this subject for the present, I shall endeavor to describe the various steps made in the development of my syntonic system. I realized a long time ago that one great difficulty in achieving the desired effect was caused by the action of the transmitting wire. A simple straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves. If this was in the beginning an advantage, by allowing signals to be received with a small amount of energy over considerable distances, it proved later to be one of the chief obstacles in the way of obtaining good resonance in the receiver. Now, as Dr. Fleming points out so clearly in his Cantor lectures on "Electrical oscillations and electric waves," delivered before the society in November and December of last year, there is in connection with this part of the subject one point of great interest. "Both theoretical and experimental research show that in the case of conductors of a certain form the electric oscillations die away with great rapidity." In all what we call good radiators electrical oscillations set up by the ordinary spark of discharge method cease, or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves. Many mechanical analogies can be quoted which will point out the necessity of designing a persistent oscillator, in order that syntony may become apparent in properly tuned resonators.

Acoustics furnish us with numerous examples of this fact, such as the resonance effects produced by the well-known tuning-fork experiment. Other illustrations of this principle may be given, e. g., if we have to set in motion a heavy pendulum by means of small thrusts or impulses these must be timed to the period of oscillation of the pendulum, since otherwise its oscillations will not acquire any perceptible amplitude. An illustration of this fact occurred to me some time ago while I was watching the ringing of great bells in an Italian cathedral. As most of you probably know, the bells in many churches in Italy, as elsewhere, are rung from the bottom of the tower by means of ropes attached to the bells. The largest bells weigh several tons, and it usually requires two men to work for perhaps two minutes on the ropes before the combined effect of their pulls is sufficient to get the bell to attain an amplitude large enough to cause the hammers to strike. I observed on the occasion to which I allude that it required for each bell a number of well-timed pulls on the ropes in order to get them to swing, the larger bells requiring impulses farther apart, i. e., of a lower frequency than the smaller ones. It is perfectly obvious that if the pulls on the ropes had been wrongly timed it would have been impossible with the same amount of power to ring the bells. The same kind of effect happens in a very small fraction of a second (instead of several minutes) when we try to induce electrical oscillations in a good resonator. If the form of this resonator be such as to cause it to be a persistent vibrator, i. e., one in which the electrical oscillations are not rapidly damped by resistance or radiation of waves, then it is necessary for us to employ a number of properly timed electrical oscillations radiated from a persistent oscillator tuned to the period of the resonator we desire to affect.

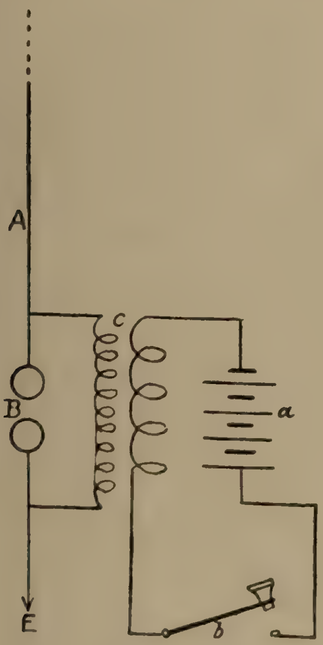

Fig. 1

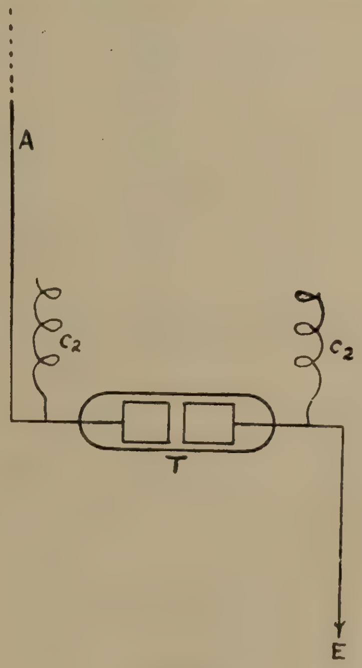

Fig. 2.

As I pointed out before, a transmitter consisting of a vertical conductor as shown in fig. 1 is not a very persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great, that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it. From the results obtained it would seem as if the transmitter were sending out a great variety of electric waves, resembling therefore a source of white light, and that each resonator picks out and responds to its own particular wave length. This view, however, is incorrect; the fact that, given certain conditions, various resonators will respond, even if their period be different from the natural period of oscillation of a transmitter, is to be accounted for by the consideration that all the energy of the transmitter is radiated in only one or two swings, with the result that oscillations may be induced in resonators of different periods, whilst, if the same amount of energy be distributed in a great number of individual feeble impulses, their combined effect can only be utilized or detected by a resonator tuned so as to respond to their particular frequency. The tuned resonator will not then respond to the first two or three oscillations but only to a longer succession of properly timed impulses, so that only after an accumulation of several swings does the E. M. F. become sufficient to break down the insulation of the coherer, and cause a signal to be recorded.

Notwithstanding the disadvantages for obtaining electrical tuning, attributed to the form of transmitter shown in fig. 1, selection of messages is possible when using, say, two or three transmitters having wires of considerably different lengths, and the induction coil or oscillation transformers on the receivers wound with varying lengths of wire in their secondary circuits, in order to cause them to be in tune or resonance with the length of wave of the transmitted oscillations, as pointed out in my British patent No. 12326, dated June 1, 1898. At page 1, line 19, this reads: "It is desirable that the induction coil should be in tune or syntony with the electrical oscillations transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave transmitted." The following experiment, which has been successfully tried, proves this point. At St. Catherines, Isle of Wight, we had a transmitting station having a vertical wire 45 meters long, and at sea, 10 miles from our receiving station at Poole, a ship with transmitting wire of 27 meters. It is, therefore, obvious that the wave length of the electric oscillations radiated from St. Catherines differed considerably from that radiated from the ship. Now, if at the receiving station at Poole we connected to a vertical wire two receivers, one having an induction coil with secondary in tune with the length of wave emitted by St. Catherines and the other with that emitted by the 27-meter feet wire on the ship, if St. Catherines and the ship transmit simultaneously two different messages, these will be picked up at Poole, and each message will be reproduced distinctly on its receiver. I pointed out in a patent specification dated December 19, 1899, No. 25185, page 2, that the best results are obtained when the length of wire of the secondary of the induction coils is equal to the length of the vertical wire used at the transmitting station, therefore the length of the secondary of the receiving induction coils was made equal to that of the transmitting wire. (Something of the same kind has been lately noticed by Professor Slaby in what he calls an extension wire.)

These results, although in a way satisfactory, did not appear to my mind a complete solution of the problem. I found it impossible to obtain the two messages at the receiving station if the two transmitting stations were placed at equal distances from it. The following considerations may perhaps explain this failure: If the 27-meter transmitting wire was placed at the same distance from Poole as the 45-meter one, i. e., 31 miles, the waves emitted by the 27-meter wire would be too weak when they reached Poole to affect the receiver. On the other hand, if the 45-meter transmitter was placed at 10 miles from the receiver, then the waves radiated by it would be so strong as to affect the receiver, tuned to respond to the 27-meter transmitter, and blur its signals.

It thus became apparent that some different form of less damped radiator was necessary in order to obtain more practical and more useful results. I carried out a great number of experiments by adding to the radiating and receiving wires inductance coils, on a principle similar to that suggested by Lodge in his 1898 patent (No. 29069), but without obtaining any satisfactory results. The failure was probably due to the fact that the electrical capacity of the exposed conductors became too small in proportion to their inductance. I then tried various methods for increasing the capacity of the radiating system. The first and obvious mode of effecting this is by an augmentation in the size of the exposed conductor, but this method is not entirely satisfactory, in consequence of the circumstance that an increased surface means increased facility for radiating the energy during the first oscillations, and also because large plates or large exposed areas are impracticable on board ship, and are always difficult to suspend and maintain in good position during windy weather. The way out of the difficulty was discovered by adopting the arrangement shown in fig. 3. Here we have an ordinary vertical radiator placed near an earthed conductor, the effect of the adjacent conductor being obviously to increase the capacity of the electrical radiating wire without in any way increasing its radiative power, and, as I had expected, syntonic results were not difficult to obtain with such an arrangement. Mention of this method has been made by Captain Ferrie, one of the members of the French Commission which was present at the tests carried out across the English Channel in 1899, in a paper on wireless telegraphy. (See paper "Etat Actuel et Progrès de la Télégraphie Sans Fil," read before the Congrès International d'Electricité, Paris, 1900.) Satisfactory results were obtained, and I was encouraged to continue my researches in order to improve the system. Early in 1900 I obtained very good results with the arrangement shown in fig. 4. This arrangement is fully described in a British patent application applied for by myself on March 21, 1900, No. 5387. In it the radiating and resonating conductors take the form of a cylinder, the earthed conductor being placed inside. This form of radiating and receiving areas is much more efficient than the one I have previously described. One necessary condition of this system is that the inductance of the two conductors should be unequal, it being preferable that the large inductance should be joined to the nonearthed conductor. I presume that, in order to radiate the necessary amount of energy, it is essential that there should be a difference in phase of the oscillations in the two conductors, as otherwise their mutual effect would be to neutralize that of each other. In the first experiments mentioned by Captain Ferrie this was obtained by simply using an earthed conductor shorter than the radiating or resonating one. When I used an inductance between the spark-gap or oscillation producer and the radiating conductor, I found it possible to cause the electrical period of oscillation of the receiving cylinder to correspond to that of one out of several transmitting stations, from which one

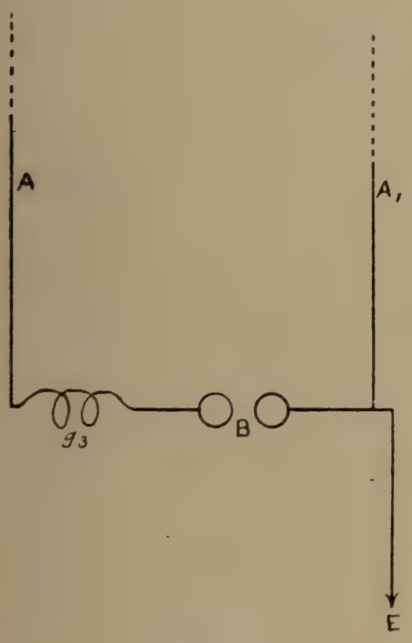

Fig. 3

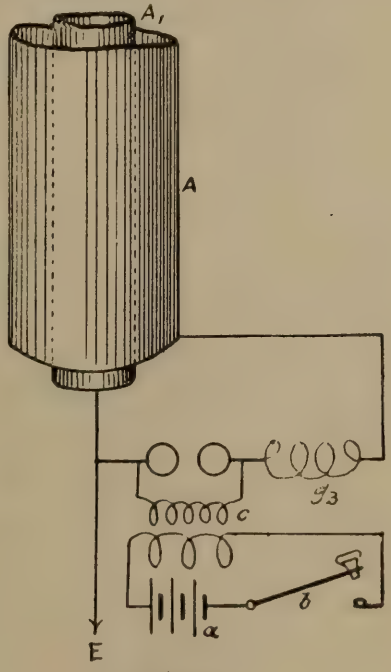

Fig 4.

alone it would receive signals. The results obtained by this system have been remarkable. By using cylinders of zinc only 7 meters high and 1.5 meters in diameter, good signals could easily be obtained between St. Catherines, Isle of Wight, and Poole (distance 31 miles), these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the admiralty in the immediate vicinity. The closely adjacent plates and large capacity of the receiver cause it to be a resonator possessing a very decided period of its own, i. e., it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves, which are sometimes probably caused by atmospheric disturbances, and which occasionally prove troublesome during the summer. It seemed very remarkable to me during my first test that an arrangement similar to that shown in fig. 4 should prove to be a good radiator and should enable such a considerable distance to be achieved with cylinders of so moderate a height. It is probable that the great majority of the electrostatic lines of force pass directly from one cylinder to the other, but it must be also true that a certain number leave the outer part of the external cylinder, exactly as in the case of an ordinary radiator. The receiver is not shown in the sketch, but consists of similar cylinders to those used for transmitting the receiving induction coil or oscillation transformer, being placed where the spark-gap is shown in fig. 4. The capacity of the radiator due to the internal conductor is, however, comparatively so large that the energy set in motion by the spark discharge can not all radiate in one or two oscillations, but forms a train of slowly damped oscillations, which is just what is required. A simple verticle wire, as shown in fig. 1, may be compared with a hollow sphere of thin metal which, when heated, would cool very rapidly, and the concentric cylinder system with a solid metal sphere, which would take a very much longer time to cool. Mr. W. G. Brown suggested, in a patent specification dated July 13, 1899, No. 14449, the use of two conductors of equal length joined to each side of the spark-gap, but he did not describe the inductance in series between them and the spark-gap, which, according to my experience, is absolutely essential for long-distance work. Another very successful syntonised transmitter and receiver system was the outcome of a series of experiments carried out with the discharge of Leyden jar circuits. Taking for granted that the chief difficulty with the old system, as shown in fig. 1, lies in the fact, as already stated, that the oscillations are very dead

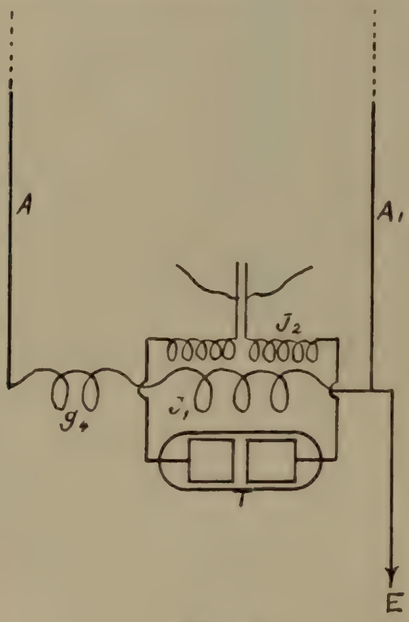

Fig. 5.

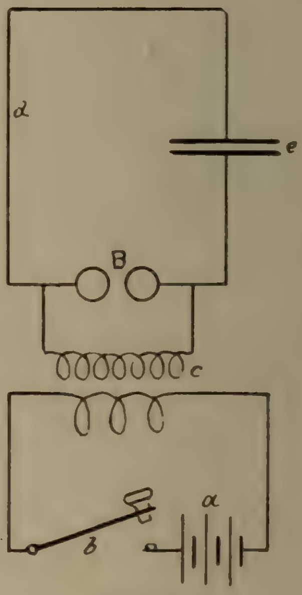

Fig 6.

beat, I tried by means of associating with the radiator wire a condenser circuit, which was known to be a persistent oscillator, to set up a series of persistent oscillations in the transmitting vertical wire.

An arrangement as shown in fig. 6, which consists in a circuit containing a condenser and a spark-gap, constitutes a very persistent oscillator. Professor Lodge has shown us how, by placing it near another similar circuit, it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars; but, as Lodge points out,[1] "A closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adopted for action at a distance." I very much doubt if it would be possible to affect an ordinary receiver at even a few hundred yards. It is very interesting to notice how easy it is to cause the energy contained in the circuits of this arrangement to radiate into space. It is sufficient to place near one of its sides a straight metal rod or good electrical radiator. The only other condition necessary for long-distance transmission is that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit.

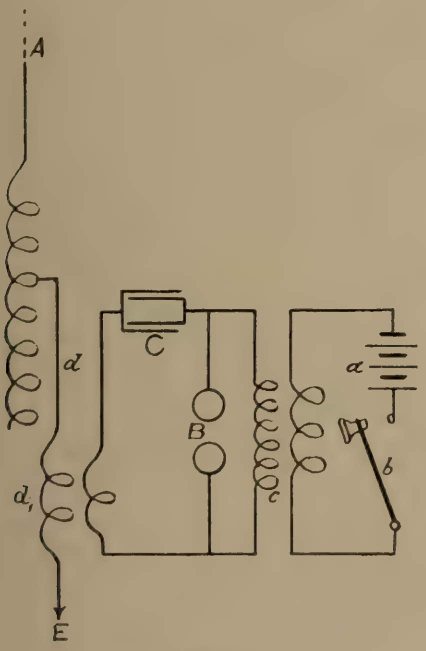

Fig. 7

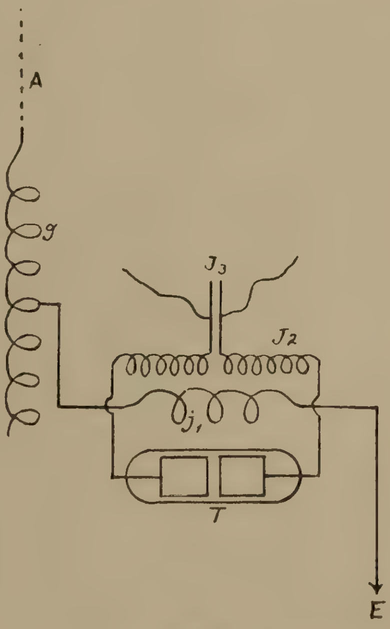

Fig. 8.

Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit, including the condenser (so as to resemble the circuits of a transformer). I first constructed an arrangement as shown in fig. 14, which consists of a Leyden jar or condenser circuit, in which is included the primary of what may be called a Tesla coil, the secondary of which is connected to the earth or aerial conductor. The idea of using a Tesla coil to produce the oscillations is not new. It was tried by the post-office officials when experimenting with my system in 1898, and also suggested in a patent specification by Dr. Lodge, dated May 10, 1897, No. 11575, and by Professor Braun in the specification of a patent dated January 26, 1899, No. 1862. My idea was to associate with this compound radiator a receiver tuned to the frequency of the oscillations set up in the vertical wire by the condenser circuit. My first trials were not successful, in consequence of the fact that I had not recognized the necessity of attempting to tune to the same period of oscillation (or octaves) the two electrical circuits of the transmitting arrangement (these circuits being the circuit consisting of the condenser and primary of the Tesla coil or transformer, and the aerial conductor and secondary of the transformer). Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonised transmitter is shown in fig. 7. The period of oscillation of the vertical conductor A can be increased by introducing turns, or decreased by diminishing their number, or by introducing a condenser in the series with it. The condenser C in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity. The receiving station arrangements are shown in figs. 8 and 9. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser across the coherer in fig. 9. Now, in order to obtain the best results, it is necessary that the free period of electrical oscillations of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that, in order to make the tuning more marked, I placed a condenser across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received, the effect of the same is summed up until the E. M. F. at the terminals of the coherer is sufficient to break down its insulation and cause a signal to be recorded.

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[1] The Work of Hertz, by O. J. Lodge, page 7.

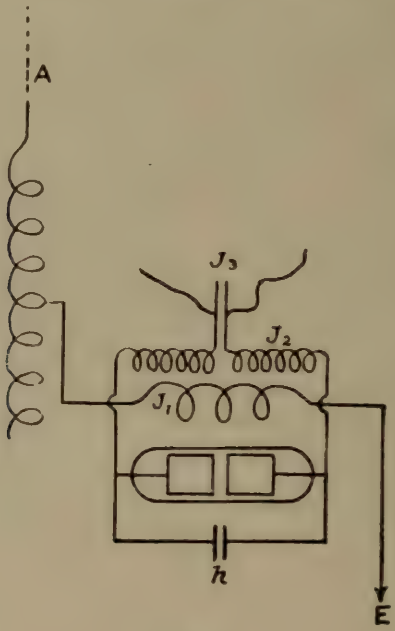


Fig. 9.

In order that the two systems, transmitter and receiver, should be in tune, it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal. A more complete and detailed description of this system is given in a British patent granted to me, dated April 26, 1900, No. 7777. I have recently found that Professor Braun has recognized the necessity of tuning the circuits of the transmitter and receiver when using a Tesla coil, in order to obtain syntonic effects, but I am not aware that such a proposal was published prior to the description given in the above-mentioned patent.

Although little difficulty has been encountered in measuring the capacity used in the various circuits, the measurement or calculation of the value of the inductance is not so easy. I have found it impracticable by any of the methods with which I am acquainted directly to measure the inductance of, say, two or three small turns of wire. As for calculating the inductance of the secondary of small transformers, the mutual effect of the vicinity of the other circuits and the effects due to mutual induction greatly complicate the problem.

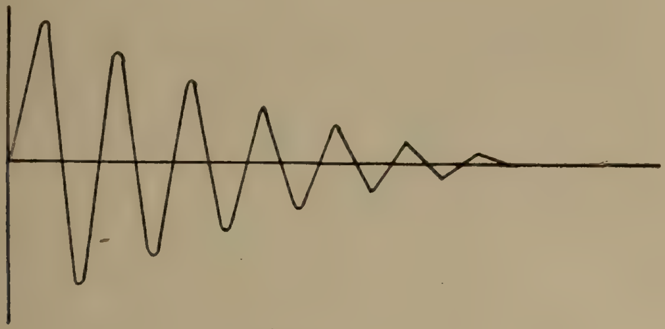


Fig. 10.

Experiments have confirmed the fact that the receiving induction coils having the secondary wound in one layer and at a certain distance, say 2 millimeters (to cause the capacity to be so small as to be negligible), have a time period approximately equal to that of a vertical conductor of equal length. (See patent granted to G. Marconi, dated December 19, 1899, No. 25186.) If, therefore, we are using an induction coil having a secondary 40 meters long on the receiver, I should use a vertical wire 40 meters long at both transmitting and receiving stations. By so doing I have the two circuits at the receiving station in tune with each other, and I only have to adjust the capacity of the condenser at the transmitter, which can easily be done, either by means of a condenser having movable plates that can be slid, more or less, over each other, or by adding or removing Leyden jars.

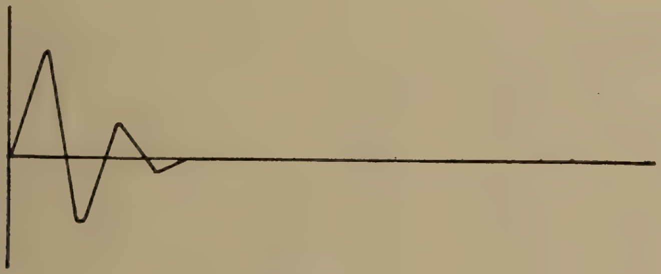


Fig 11.

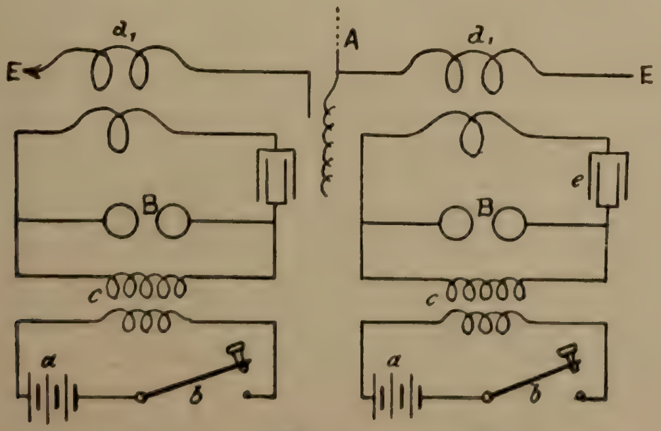


Fig. 12.

If we start with a very small capacity, which we gradually increase, a value of the capacity will be reached which will cause signals to be recorded on the receiver. Supposing the receiving system to be within the sphere of action of the transmitter, then the signals will be strongest when the capacity of the condenser is of a certain value. If we still increase the capacity, the signals will gradually die away, while if we go on increasing the capacity and at the same time add inductance to the aerial, to keep it in tune with the condenser-jar circuit, we are still radiating waves, but these do not affect the receiver. If, however, at the receiving station we add inductance or capacity to the wire A, fig. 9, and also to the ends of the secondary of J 2, we find ourselves able to receive messages from the transmitter, although we are utilizing waves of a different frequency.

It is easy to understand that if we have several receiving stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them without danger of the message being picked up by the other stations for which it is not intended. But, better than this, we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers. Different messages can be sent by each transmitter connected to the same radiating wire simultaneously, and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe to be quite novel, I showed to several friends of mine, including Dr. Fleming, F. R. S., in the summer of last year, and to an admiralty commission. Dr. Fleming has made mention of the results I showed him, in a letter to the Times, dated October 4, 1900, and in his Cantor lectures delivered before the Society of Arts in November and December, 1900. A further improvement has been obtained by the combination of the two systems. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly tuned induction coil, and all circuits must be tuned to the same period as already described. (See fig. 16.)

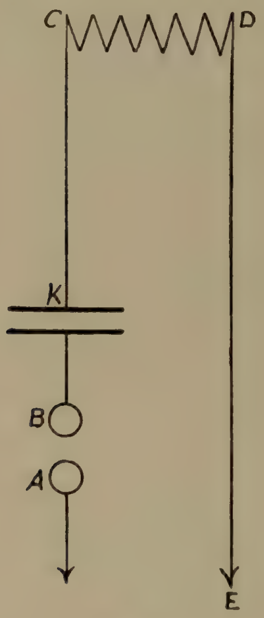


Fig. 13.

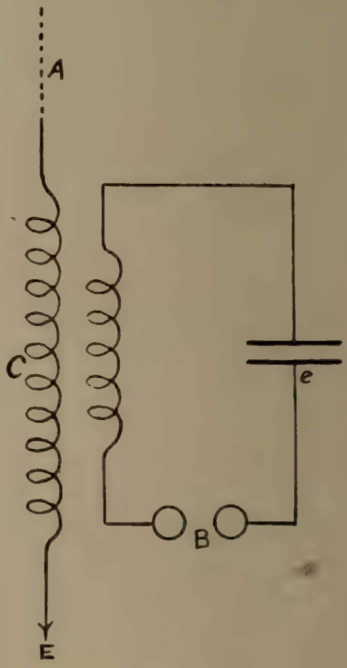


Fig. 14.

The tuning of the receiver to respond to the period of the transmitter, as used in the old form of transmitter shown in fig. 1, or in the new one shown in fig. 7, has enabled results to be obtained over considerable distances with moderate heights.

As already published by Dr. Fleming in the letter above referred to, signaling has been successfully carried out over a distance of 50 kilometers with a cylinder only 1.25 meters high, 40 inches in diameter. This has led to the possibility of constructing portable apparatus for army purposes, which should be of great service in the field. I have succeeded in constructing a complete installation on a steam motor car. On the roof of the car there is placed a cylinder which can be lowered when traveling, its height being only 6 or 7 meters, and by this means communication has been easily carried out with a syntonized station over a distance of 31 miles. A 25-centimeter spark induction coil worked by accumulators and taking about 100 watts is used for transmitting, and the accumulators can be recharged by a small dynamo worked by the car motor. I believe such an appliance might have been of use to the besieged garrisons in South Africa and China. A strip of wire netting laid on the ground is sufficient for earth connection, and by dragging it along communication can be established even when the car is traveling. I have recently obtained as good results by not using any "connection" to earth, but only utilizing in lieu of earth the electrical capacity of the boiler of the motor car. I also find that signals can be transmitted a considerable distance with the cylinder in a horizontal position.

Last spring I recognized the desirability of carrying out tests between stations situated at much greater distances apart than had been attempted heretofore. A station was established at the Lizard, Cornwall, and on the first attempt communication was effected with St. Catherines, Isle of Wight, over a distance of 186 miles, which, I believe, is the record distance over which signals have been sent through space without wires. It is interesting to observe that signals were obtained over this distance with the transmitting apparatus as shown in fig. 1, or with the arrangement shown in fig. 7, provided always that a suitable resonating induction coil was employed at the receiving station. The amount of energy used for signaling over this distance is not more than 150 watts, but experiments with a larger amount of energy will shortly be carried out. In the case of the 186-mile transmission the aerial conductor consisted of four parallel vertical wires 1.50 meters apart, 48 meters long, or in a strip of wire netting of the same length. It is interesting to note that in order to communicate between my stations at Poole and St. Catherines (distance 31 miles) with the same amount of energy and the same kind of aerial wire this must be 20 meters high to obtain signals of about the same strength as those obtained between the 186-mile stations with the 48-meter aerials. This goes to confirm many other results previously obtained, which indicate that with a parity of other conditions the distance varies with the square of the height of the vertical conductors at the two stations. I have always found this law fulfilled, if the height of the conductors at the two stations is approximately equal, although an attempt has been made recently to throw doubt upon its correctness.

You will admit that the progress achieved in syntonic space telegraphy must have enormously increased its field of application and usefulness, since a very great number of noninterfering stations can now be worked in the immediate vicinity of each other. It will probably be of interest if I give you a few examples of the progress made in the practical utilization of my system. An eminent electrician recently expressed a doubt whether there was at present a single circuit worked commercially on a practical system of wireless telegraphy. If earning a revenue from working installations can be termed a commercial working, even such an incomplete list of these as time will now permit me to give you, and which are now all in permanent working order, may be sufficient proof that a beginning at least has been made in the commercial utilization of the system.

In March, 1900, there were in use in the royal navy, in South African waters, five installations of my system. The Admiralty was apparently well satisfied with its working, since in May of last year they decided to extend its adoption to 32 more ships and land stations. The conditions of the contract were that each apparatus, before being accepted, should be satisfactorily worked by naval signalmen between two ships anchored at Portsmouth and Portland, over a distance of 62 miles, a considerable portion of which—i. e., 18 miles—lies over land, with intervening hills, and the height of aerial wire was specified not to exceed on each ship 49 meters. The apparatus was delivered in a comparatively short time, no sets having been found unsatisfactory. The apparatus supplied to the Admiralty is so far all of the old pattern—i. e., the nonsyntonized system; and I have been informed that messages have been transmitted and received by naval signalmen between ships more than 160 kilometers apart. It sometimes occurs that the unfamiliarity of the operators with the particular kind of apparatus used caused unsatisfactory results to be obtained, but I believe this trouble will soon disappear. I am glad to be able to state that arrangements are being made to install my new syntonic apparatus upon several of His Majesty's ships. I believe that in no other navy in the world is wireless telegraphy being worked regularly over such considerable distances. My system is also used for communication between the Borkum riff and Borkum light-ship in Germany, where an ordinary commercial charge is made for messages received from ships, and it is employed, further, on the Nord Deutscher Lloyd's mail steamer *Kaiser Wilhelm der Grosse.*

According to an official report of the imperial postal authorities of Oldenburg, the total number of commercial wireless telegrams transmitted from and to the light-ship between May 15 and the end of October amounted to 565, and of these 518 came from ships at sea, while 47 were transmitted to ships. Of the 518 telegrams, 35.7 per cent were addressed to the Nord Deutscher Lloyd and 64.3 per cent to other shipping firms. The installations are worked by ordinary operators in a most satisfactory manner, and on one occasion assistance was obtained for a man who was taken suddenly ill on the Borkum riff, and it was thus made possible to hand him over promptly for medical treatment on shore.

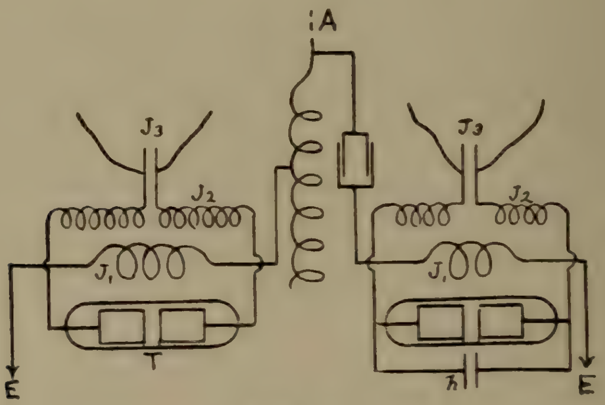


Fig. 15.

The system has been in operation at La Panne, near Ostend, and on the Belgian mail steamer *Princess Clémentine,* which plies to Dover. With a height of only 22 meters on the ship, it has been found practicable to communicate from Dover Harbor to La Panne, 43 miles away, and this installation has proved of value in saving life and property. Thus, recently, a bark was wrecked on the Rattel Bank. The *Princess Clémentine,* which happened to pass near, at once sent a message to Ostend, and, before leaving, was able to tell the shipwrecked sailors that assistance was on the way. The men were all saved. On another day, coming within sighting distance of the Ruytingen light-ship, situated about 15½ miles from Dunkirk, the captain of the *Princess Clémentine* observed that he was being signaled. It appears that the lighting apparatus of the Ruytingen had got out of order. The captain of the mail packet immediately dispatched a message, which was received by the installation at La Panne and repeated to the light-house department at Dunkirk. A crew immediately set out for the light-ship and effected the necessary repairs, and the great inconvenience and danger of the light-ship not being able to have the lights in order was averted.

Another instance of the usefulness of the wireless telegraphy in an emergency was furnished when the *Princess Clémentine* herself went ashore on the Belgian coast during a fog. Within a few minutes of the accident news of it was telegraphed from the stranded ship to Ostend, with the result that a tug was at once dispatched to her assistance and she got off at the next high tide. So successful has the installation of wireless telegraphy been on the mail steamer *Princess Clémentine*, between Dover and Ostend, that similar apparatus is to be fitted on the other vessels of the same fleet.

The system has been in use, furthermore, since March 1 last for ordinary commercial telegraphy between the Sandwich Islands, where a regular charge is made for the same. An installation has also been successfully carried out by my assistants for the French Government between Antibes, in France, and Corsica, a distance of 124 miles.

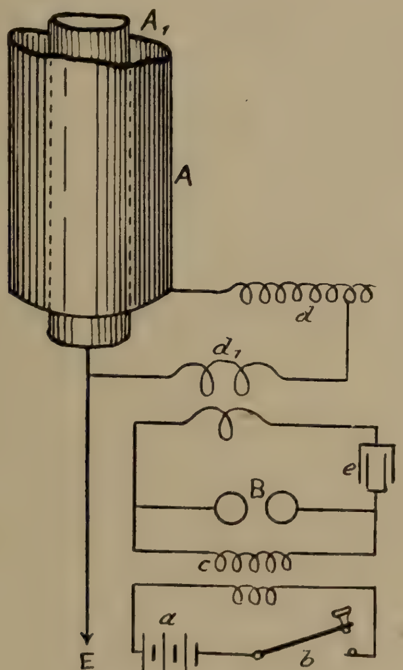


Fig. 16

As has already been published in the daily papers, much use has been made of my system in the navy during the voyage of the Duke and Duchess of Cornwall and York to Australia.

I have tried lately to ascertain how near a tuned transmitter which is radiating waves of a certain frequency must be to a receiver tuned to a different frequency in order that the said receiver shall be affected. I find that if we are working with oscillations which differ very considerably in period, a transmitter capable of sending signals 31 miles to a tuned receiver will not affect a nontuned one at 50 meters. If the periods of oscillation of the two tunes are more similar to each other, then the nontuned receiver may be affected even at several kilometers.

Considerable use is still made of the nontuned system at my experimental stations, in order to be able to communicate with ships fitted with what I call the old system, and also in order to be able to communicate with the naval station at Portsmouth.

Before concluding, I wish to say a few words on a method proposed by Professor Slaby, and with which I have also carried out some experiments. As transmitter Slaby uses an arrangement, as shown in fig. 13, which consists of a vertical conductor in which is interposed a condenser K and a spark gap B. The top of the wire is not free, but is connected to earth through an inductance C D and a wire E. At the receiving station the arrangement shown in fig. 17 is employed. It consists in a vertical conductor D C, connected to earth at C, which should be the nodal point of the waves induced in the wire D C, where there is joined another wire, termed an extension wire, of equal length. In this case Slaby places an apparatus which he calls a "multiplicator," connected to the coherer between the end of the extension wire and the earth; or by another arrangement (fig. 17), he uses a loop wire F G H D C E, the multiplicator being placed between E and F in series with the extension wire J. By means of this arrangement Slaby, on December 22 of last year, showed the reception of two different messages sent from two transmitting stations situated at unequal distances from the receiving station to be possible, one station being at 4 kilometers and the other at 14 kilometers, thus obtaining a result which may be considered similar to that obtained by me some months previously over larger distances. (See Professor Fleming's letter in the Times of October 4, 1900.) The information given in Slaby's paper, as published in the *Elektrotechnische Zeitschrift*, is exceedingly incomplete. We are not told what was the amount of energy used for the transmission nor the height of the vertical conductor at the receiving station or at the transmitting station at the Aberspree Kablewurks. We are told that the transmission wire was suspended between the chimney shafts. Very little information is given as to the appliance which Dr. Slaby calls a multiplicator. G. Kapp, who is probably acquainted with the details of Slaby's work, commenting on this paper of his, calls the instrument in question "an especially wound induction coil ('induction spule'), the function of which is to increase the E. M. F. of the oscillations at the ends of the coherer." Upon reading this for the first time, I assumed that the multiplicator was an oscillation transformer performing the function of those described in my patent dated June 1, 1898, and also described in my Royal Institution lecture of February 2, 1901. As I subsequently, however, discovered, Professor Slaby, referring to the multiplicator, states: "This apparatus in its most simple form consists of a wire coil of a determined shape and form of winding, which depends upon the length of the wave. * * * I might call this apparatus, unknown to my knowledge up to the present, a multiplicator. It is not to be confounded with a transformer, as it has no secondary winding."

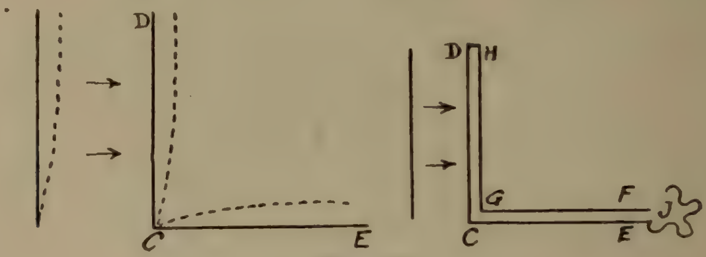


Fig. 17

This statement appears to me very ambiguous, as I always have understood that what we call transformers need not have a distinct secondary winding. An appliance called an autotransformer was used by the Westinghouse Company for regulating the E. M. F. supplied to house-lighting installations, which consisted in a single winding, a certain number of turns acting inductively on the adjacent ones. (See "The Alternate-Current Transformer, by J. A. Fleming, Vol. II, pp. 187, 188.) One of the first transformers ever made is shown in the work above referred to, Volume II, pages 6 and 7. At page 6 we read: "Page really made the first experiment in autoinduction and showed that different parts of the same conductor might act as primary and secondary circuits to each other if in contiguity."

I installed the apparatus described by Slaby at Niton, Isle of Wight, and at Poole, using wires 35 meters high, but with the receiving wire earthed at C (fig. 17) of the loop I could receive nothing, although I tried various frequencies of oscillation. It is, however, probable that I might have received had I been working over much shorter distances than 50 kilometers, as Slaby did in his demonstration, or had I used a greater height of wire. By using, however, my method of connection—i. e., introducing between the vertical wire and earth an oscillation transformer having its circuits tuned to the frequency given by an ordinary vertical radiating conductor of length equal to the Slaby wire A C—I succeeded, by means of extremely sensitive coherers, in obtaining communication. I then tried the following experiment: I took down the earth wire E D and the inductance D C, and used only the conductor A C insulated, with the condenser in circuit for transmitting. An enormous strengthening of the signals at the receiver was immediately obtained, which obviously means a greater ease of working and the possibility of obtaining signals over greater distances. The reasons which demonstrate that a closed circuit, such as is employed by Slaby, must be a poor radiator are obvious to those who have studied and read the classical works published since the time of Hertz's experiments.

Dr. Slaby, however, states that the inductance at the top of his loop confines the oscillations to the vertical part AC. If this be the case, the frequency of these local oscillations can not be equal to that of the whole circuit ACDE, which it has been stated was so easy to calculate, if the translations of Slaby's paper I am relying on are correct. I believe that, notwithstanding the inductance CD, a considerable amount of energy must pass to earth through the earth wire, which acts as a leak uselessly dissipating energy which should be radiated into space in the form of ether waves. If these conclusions are correct, I am not at all clear as to what necessity there is for employing the earthed conductor ED and the inductance. It is not necessary for obtaining syntonic effects from transmitting stations placed at unequal distances from the receiver, as this can be obtained when using the primitive form of transmitter shown in fig. 1; and Slaby has not yet described how to obtain different messages from transmitters situated at equal distances from the receivers, which is much more difficult in my experience; nor does it appear possible, with the method he describes, to transmit various messages at the same time from one sending wire as can be done with the system I have just explained. The distance obtained with the closed transmitting arrangement must be comparatively small.

As I have already stated, communication over a distance of 300 kilometers is now being maintained with my system, but I am not aware of anything approaching even 100 kilometers being achieved with the loop transmitter. It may be said that long distances of transmission are not necessarily an advantage, but I notice that the Navy wants long-distance apparatus supplied to it. I have also tried connections similar to Slaby's extension wire in the receiver, but I find that the real sifting out of waves is done in the oscillation transformer, although sometimes it may be desirable to increase the period of oscillation of the aerial conductor by adding inductance to it, or at other times to decrease its period by placing a suitable condenser in series with it. I trust it will not be thought that I wish in any way to minimize the importance of Slaby's work. I only wish to get at the facts and to draw a discussion on a very interesting subject.

Time does not permit me to refer to a great number of experiments upon which I am now engaged, or which have been carried out by others, but I hope on a future occasion to describe better results. I have come to the conclusion that the days of the nontuned system are numbered. The ether about the English Channel has become, in consequence of great wireless activity, exceedingly lively, and a nontuned receiver keeps picking up messages or parts of messages from various sources which very often render unreadable the message one is trying to receive. I am glad to say, however, that I am now prepared with syntonic apparatus suitable for commercial purposes. And, as my final word on the general subject for the present, let me say that those who are responsible for the recent development of wireless telegraphy into a practical science can not fail to find great satisfaction in the reflection that, as already life has been saved that without this discovery would have been lost, so, in the future, apart from its manifold commercial possibilities, valuable as these are, humanity is likely to have before very long to recognize in telegraphy through space without connecting wires the most potent safeguard that has yet been devised to reduce the perils of the world's sea-going population.

DISCUSSION.

Dr. Fleming, F. R. S., said that as he had been permitted to be a little behind the scenes, and had seen some of the apparatus before it was made public, he was able to entirely confirm Mr. Marconi's statements with regard to his experiments. A very great stride forward had been made in syntonic telegraphy. The subject was not a new one—in fact, a large number of patents had been taken out in connection with it, most of which, however, embodied more hope than experience. In spite of the fact that there were so many claims of priority in the matter, he had the strongest possible conviction that Mr. Marconi was the first person to actually achieve a true syntonic telegraphy with electric waves. He had done that in virtue of having followed out to their logical issue the fundamental scientific principles of the subject which he had so clearly grasped, one of which was the essential distinction between the radiative and the nonradiative circuit. Many inventors and patentees had professed to have obtained syntonic telegraphy with a simple open aerial insulated radiator of the Marconi type. Although it was possible to produce a kind of bastard syntonic telegraphy by that means, it was not possible to produce true syntonic telegraphy, because the aerial simply produced a sort of etheric impulse or explosion and not a true train of waves. It was just as possible to produce true syntonic telegraphy by those means as it would be to cause one whip to crack by cracking another near to it. When a closed circuit was taken, which was a powerful absorber of electric energy and associated with a radiative circuit, a means was obtained for producing a true train of waves. If those two circuits were tuned together a great improvement was effected on anything previously accomplished. Mr. Marconi had not only constructed a receiver capable of receiving trains of waves, but also capable of not receiving those not adapted to it. No train of waves would act upon his syntonic receiver except those which had a particular period. An analogy might be found in a cork floating on water, which would be bobbed up and down by any wave, long or short, which went over it; but a heavy log of wood floating on the water and tethered to the bottom of the sea by a spiral spring would only be caused to bob up and down by waves having one particular period. The former corresponded to a simple coherer, and the latter to a syntonic receiver of the kind described in the paper. He quite agreed with Mr. Marconi that the days of the nonsyntonic telegraphy were numbered, because no one would chose a receiver capable of being affected by every vagrant wave when such an instrument as Mr. Marconi's latest form of receiver was available. Among the possibilities which lay in front of the invention was that it would be immediately possible to provide the admiralty and the post-office with instruments having an admiralty or post-office frequency, and to register frequency just as a telegraphic address was registered, so that no one else could use that particular frequency. He had had the privilege of riding on the motor car described by the reader of the paper, and, when many miles from home, they were able to communicate with their hotel and order their lunches. In conclusion, he offered his warmest congratulations to Mr. Marconi on the immense strides he had made in the improvement of his initial invention.

Captain Kennedy, R. E., said he wished to explain, in common justice to Mr. Marconi, some of the points connected with the operation of the system in South Africa. A scheme was suddenly conceived and hastily executed of sending apparatus and assistants to install the system at Durban. But instead of setting it up at that port, it was sent to the front. No poles were available, and the attempts to substitute kites and balloons were unsuccessful. For want of labor and proper materials progress was slow, and eventually the work was stopped. On arriving in Natal, on the first opportunity, he handed the whole system over to Capt. Percy Scott, who worked it most satisfactorily on board the ships at Durban up to the time he left South Africa. The operations in Cape Colony were entirely experimental, and would have succeeded had they been given a fair chance.

The chairman (Professor Ayrton) in proposing a vote of thanks to Mr. Marconi for his admirable paper, said that, after listening to what wireless telegraphy had already done in saving life and ships, they realized why the reader of the paper, although so young, had acquired fame; why he had won that more substantial reward which sometimes went with fame, but often did not, and also grasped why he had earned what should be dearer to him than fame or wealth—the gratitude of all peoples for having so courageously developed a new sense for the world. Although still far away, he thought they were gradually coming within thinkable distance of the realization of a prophecy he ventured to make four years ago, of a time when, if a person wanted to call to a friend he knew not where, he would call in a loud, electro-magnetic voice, heard by him who had the electro-magnetic ear, silent to him who had it not. "Where are you?" he would say. A small reply would come, "I am at the bottom of a coal mine, or crossing the Andes, or in the middle of the Pacific." Or, perhaps, in spite of all the calling, no reply would come, and the person would then know his friend was dead. Let them think of what that meant, of the calling which went on every day from room to room of a house, and then think of that calling extending from pole to pole—not a noisy babble, but a call audible to him who wanted to hear and absolutely silent to him who did not; it was almost like dream-land and ghost land—not the ghost land of the heated imagination cultivated by the Psychical Society, but a real communication from a distance based on true physical laws. On seeing the young faces of so many present he was filled with green envy that they, and not he, might very likely live to see the fulfillment of his prophecy.

Mr. Marconi, in reply, thanked Dr. Fleming for his kind remarks. To him he was also indebted for valuable advice on many subjects he did not understand, and in which Dr. Fleming's theoretical knowledge was of great value. In reference to Captain Kennedy's remarks, he wished to give an explanation. When the war broke out in South Africa he was asked whether he could send his apparatus out there. His associates, in reply, made two proposals: (1) To send apparatus for work at the front, and (2) between shore stations and the transports at Durban. The proposal of using the apparatus at the front was not accepted by the war office at the time. The apparatus was sent out without poles because he was informed they would be found at Durban. On the arrival of his assistants in South Africa they pluckily volunteered to go to the front, thinking the system might be worked with advantage to the English army; but, on reaching the front, poles could not be obtained by which to raise the wires. At that time, according to the old-fashioned system, this was absolutely necessary. Captain Baden-Powell came to the rescue with some well-designed kites, and signals were transmitted about 18 miles. Although the system was never used during operations in South Africa, it was not the fault of the system.

V.

SOME NAVY LEAGUES—WHAT THEY ARE AND WHAT THEY ARE DOING.

By Lieutenant Orlo S. Knepper, United States Navy,
Staff Intelligence Officer.

The influence of navies on the fate of nations has been growing year by year until now no nation, whatever may be its military power or its geographical position, can figure as a great world-nation unless it be strong on the sea. To some, of course, this strength is more important than to others. To England it is life. But no matter what the country, if it falls behind in the race for naval supremacy it falls behind in the race for greatness.

This fact is realized by all the principal powers, and effort is being made to educate the mass of the people to the same idea. This task has been undertaken by various navy leagues, and, in one country, at least, with marked success. The modern navy league is a comparatively recent institution, though we have no trouble in tracing it to ancient history. Athens rose to the zenith of her power after the battle of Salamis—her Trafalgar—and the story of her final fall, caused by neglect to rebuild and reorganize the fleet, is a story full of instruction to those who read with open eyes. The Athenian fleet that won the battle of Salamis was largely supplied and supported by private contributions of individual citizens. But in Rome we have perhaps the first organized navy league and the best example of what a navy league can do. In the year 249 *B. C.* Rome had already been engaged for some time in her desperate struggle with Carthage for the empire of the world. The first part of the war was largely naval and the Romans were no match for the Carthagenian sailors. Yet they struggled on, learning lessons by their defeat, until at last the courage of the rulers faltered. In the previous six years they had lost more than 600 ships of war in battle and storm, and of these nearly 200, with 800 transports, had been destroyed within the year. The Government gave up and no effort was made to rebuild their fleet. Then was organized the first navy league. The wealthier patriots of the city leagued together in the year 243 *B. C.* and built a fleet of 250 battleships on an improved model. These they manned and carefully trained at their own expense and then presented them to the Government. The result is history. On March 10 of the following year this volunteer fleet met and destroyed the Carthagenian fleet, and with the fleet the dream of Carthage. To quote Mommsen: "The last great effort of the Roman patriots had borne fruit; it brought victory, and with victory peace."

The modern navy league will not likely be called on to build fleets, though in some instances they have given material aid, as, for example, the Government of Natal furnishes the British navy annually with 12,000 tons of coal free, and the Cape Colony is preparing to build a battleship to be presented to the Government. But the work of the modern navy league is primarily to educate the people to the needs of a great navy and in that way influence legislation. The expenditure on a navy is held to be the premium paid on the insurance of the country, and, in some cases at least, this simile is just. With our appropriation for the next fiscal year of less than ninety millions we pay only about a dollar per capita for this insurance.

An important result of the organization of navy leagues abroad is the increased facilities for recruiting for the navy. It brings a great many young men from inland parts of the country in touch with the navy and many volunteers for service have resulted.

The following brief accounts of various navy leagues abroad are given to show their organization and what they are accomplishing, and to show how the fight for maritime supremacy is taking hold of the world in general:

THE BRITISH NAVY LEAGUE.

The first of the modern navy leagues—the British—was established only as recently as 1894. Since then it has grown rapidly and has branches in most of the principal cities of England, many of the schools and colleges, and in nearly every British colony the world over.

The organization of the league, with its object and manner of working, is best given by the constitution of the league and the following leaflets printed by the league and extensively circulated throughout the entire British Empire:

CONSTITUTION OF THE NAVY LEAGUE.

1. This association shall be called "The Navy League." Its purpose shall be to secure as the primary object of the national policy "the command of the sea."

2. The general aims of The Navy League shall be—

(*a*) To spread information showing the vital importance to the British Empire of the naval supremacy upon which depend its trade, empire, and national existence.

(*b*) To call attention to the enormous demands which war would make upon the navy, and to the fact that the navy is not strong enough to meet them, and at all times to point out any shortcomings in this respect.

(*c*) To call attention from time to time to such measures as may be requisite to secure adequate preparation for the maritime defense of the Empire.

(*d*) To urge these matters on public men and, in particular, upon candidates for Parliament.

3. The league shall be absolutely distinct from all party politics.

4. All persons approving of its aims and contributing to its funds, according to the following rates of subscription, shall be honorable vice-presidents, members, or associates of the league, as the case may be, viz:

	£	s.	d.
Honorable vice-presidents (annually)	5	0	0
For life	25	0	0
Members, gentlemen (annually)	1	1	0
For life	10	10	0
Members, ladies (annually)		10	6
For life	5	5	0
Associates:			
With publications post free, not less than (annually)		5	0
Without publications, any less amount.			

PROGRAM OF ACTION.

With a view to aims (*a*) and (*b*):

(1) The circulation of a list of books and articles conveying the information specified in the first and second general aims of the league.

(2) That copies of the more important works be presented to chambers of commerce, public libraries, and similar institutions.

(3) That, with the concurrence of authors and publishers, selected passages from some of these books be reprinted and circulated by the league.

(4) The publication by the league of such original essays and papers as may be thought desirable.

(5) The formation of a library of reference and collection there of reports and evidence of committees and royal commissions, newspaper articles, pamphlets, etc., bearing on the business of the league.

(6) That a list of duly qualified lecturers be prepared, and arrangements made for lectures to be given under the auspices of the league in the principal towns of the United Kingdom.

(7) That the league should enter into communication with all nonpolitical bodies organized for the purpose of urging the unity of the Empire, and should press upon their attention its general aim, and endeavor to facilitate their work so far as it includes this aim.

(8) That steps be taken to acquaint leaders of public opinion in the colonies and dependencies with the scope of the league's work, and that they be invited to form branches of the league.

With regard to the third general aim (*c*):

(1) That the executive of the league place itself in communication with members of Parliament with a view to ascertaining what effect has been given to the unanimous recommendations contained in the report of the royal commission of 1890 relative to the appointment of naval lords to the Admiralty.

With regard to the fourth general aim (*d*):

(1) That test questions be prepared and put to candidates for Parliament.

(2) That the executive of the league arrange for public meetings in support of the aims.

THE OBJECTS OF THE NAVY LEAGUE.

First. To bring home to every man, woman, and child in the United Kingdom that the bulk of the raw material used in our manufactures, and two-thirds of the food we eat, is transported across the sea. That if the supply of material and the export of manufactured products is arrested, the wage fund will disappear, so that the purchasing power of the people must prove utterly inadequate to their needs, and the available store of provisions, however increased, will be entirely beyond their means. That, consequently, fortifications and military strength adequate to resist invasion will be powerless to avert national disaster. That the protection of commerce at sea is, therefore, vital to the people of this country, and especially to the working classes. That commerce can be guarded only by a supremely powerful navy, able to assert and to maintain the command of the sea.

Second. To convince every taxpayer and every politician that judicious expenditure upon the navy is, for the nation, only the ordinary insurance which no sane person grudges in private affairs, applied to risks appalling in their nature and extent.

Third. To enlist, on national grounds, the support of all classes in maintaining the fleet at the requisite standard of strength, and to denounce any shortcomings in this respect.

Fourth. To insist that the question of the navy lies above and beyond all considerations of party politics, that a sudden development of naval strength is impossible, and that continuity of preparation is the essence of national security, and the only preventative of ruinous and discreditable scares.

Fifth. Throughout the Empire to explain by lectures, by the dissemination of literature, by meetings, and by private propaganda, how naval supremacy, the heritage handed down by generations of British seamen, has been alike the source of national prosperity and the sure safeguard of the liberties of the people in periods of stress.

Sixth and finally. By inculcating and strenuously upholding the principles of a great national policy based upon sea power, to bind together the scattered members of the Empire into one great whole, united in interest as in heart, and prepared to maintain intact in territory, and untarnished in honor, the splendid inheritance received from our forefathers.

THE NAVY LEAGUE JOURNAL.

The Navy League Journal is a monthly publication and is the official organ of the league. It is a journal of about 15 pages, and gives all the current naval news and full reports of all navy league matters. Special attention is given to the shipbuilding programs of all the great naval powers, and the accepted British axiom that the British navy must be at least equal to the two next strongest fleets of the world combined, plus a reserve for unexpected contingencies, is always kept to the front. Illustrations of foreign ships and tables of comparison are numerous, and everything is done to give the public a knowledge of the navy, what it has done in the past, what it is doing now, and what it must do in the future, if England is to remain a world power. The circulation of the Journal in May, 1900, was 8,000 monthly.

THE PARLIAMENTARY ELECTIONS.

In the elections to Parliament in the fall of 1900 the navy league took a prominent part, always working for a stronger navy, irrespective of party politics. The following is an example of a circular that appeared in every paper and was circulated in every corner of the Empire:

the navy! THE NAVY!! THE NAVY!!!

To the electors:

The executive committee of the Navy League note that in none of the manifestoes issued by the leaders of the two great political parties is any specific mentions made of the necessity for augmenting our naval strength.

Our naval position to-day is compromised by the failure to carry out that naval shipbuilding program stated by Mr. Goschen to be the least that would meet our requirements, and for which money voted by the late Parliament is still unspent.

The Navy League therefore submit the following questions, which they suggest should be asked of all candidates for Parliament throughout the Kingdom, and they hope that their fellow-countrymen will assist them in this important matter:

1. Are you aware that the officer in command of the Channel Squadron said at Greenock on May 11 last "that he considered he had not enough battleships and cruisers to meet any great emergency that might arise?"
2. Will you pledge yourself to require from the Government, irrespective of party, the provision and maintenance of that standard of naval strength in modern and effective warships, their necessaries and auxiliaries, which is sufficient to hold command of the sea against a coalition of any two other maritime powers?
3. Will you urge legislation tending to restore British seamen to the vessels of the British mercantile marine?

Electors! Do not be put off with vague assertions from your candidates, but ask them for a definite pledge on this vital subject, *and see that you get it.*

Vote for a strong navy and peace.

THE BRITISH MERCHANT MARINE.

The number of foreign seamen in the British merchant marine has increased from 9 per cent in 1860 to nearly 41 per cent in 1897. As in time of war England's naval reserve would be largely drawn from her merchant marine, this condition of affairs is most undesirable, and the Navy League has taken up the problem of manning the merchant marine by Englishmen and generally raising the standard of the merchant seaman.

FINANCES.

The expenses of the Navy League for the years 1898, 1899, and 1900 were £2,083, £2,351, and £2,708, respectively, and each year a balance of from £200 to £300 was left in the treasury.

EDUCATIONAL.

Every endeavor is made to encourage the study of naval history in the schools throughout the country, and to this end prizes are offered for the best essays on naval subjects.

GERMANY.

The German Navy League, modeled largely after the British Navy League, was organized April 30, 1898. Since that time its growth has been almost phenomenal. It has been in keeping with the enormous strides Germany has made for commercial and maritime supremacy, and in a great measure has been the cause of those strides.

Germany has long been considered one of the first, if not the first, great military power, but as a maritime power she has ranked only fourth or fifth. This it is realized must be overcome, and undoubtedly the standard at which Germany is aiming to-day is to become as strong as any of her rivals on the sea. But to gain this end a preliminary condition must be fulfilled—the whole nation must be brought to take an intelligent interest in its navy, to believe in it, and to work for it. In other words, the nation must be given a naval education. This, then, is the work of the Navy League. How well it is succeeding the figures show. The Emperor and the Government are strong supporters of the league and in nearly every province some German prince is at its head.

The following translation of an article in the Tribuna, the leading newspaper in Rome, is of interest as showing the objects of the German Navy League:

> Until the year 1871 no German ensign floated on the seas. Those of the free cities—Bremen, Lübeck, Hamburg—and those of Prussia and of other German states were rarely seen.
>
> The ancient device of the Hansa—Navigare necesse est, vivere non est necesse—seemed to have been forgotten by the German people, as also were the few naval traditions, and the constitution of the Empire was hailed by all as a great and powerful continental state.
>
> The first German national statistics, published in 1871, assigned to Germany 171 steamboats of a total capacity of 82,000 tons. This was insufficient even for the time, and an attempt was, therefore, made to start navigation companies and to initiate traffic with distant lands; but the first attempts proved failures, and he would have been a bold man who, twenty years ago, had ventured to prognosticate the present maritime prosperity of Germany.
>
> Having fallen completely behind in the commercial race in which all civilized nations competed on every sea, she has in a few years regained the second place, leaving France (who had previously occupied it) far behind her.
>
> The geographical configuration of the Empire, the peculiar position of her maritime cities, her great military power, and above all the inaccessibility of her coasts, make it almost superfluous for Germany to possess a war fleet for defense, yet it is to be noted that she has spent enormous sums of money in constructing a battle fleet capable of competing with the first in the world.
>
> Why? In order to guarantee blessings of peace—reply the Emperor and his councilors—to enable us to enjoy our acquired property and continually to increase it, to extend the military power of the state in distant lands, and to use her for the benefits of commerce and for the protection of emigrants.
>
> It was a vast scheme, one answering to the necessities of the nation, but difficult to accomplish, because the demand for the necessary funds would be resisted by the ultramontanes, agrarians, and socialists.
>
> A struggle was unavoidable in the Reichstag, and still more so outside it, because by far the greater part of the population living in the interior of the continent had almost forgotten maritime traditions, the fleet was unpopular, and its functions in the State practically neglected.
>
> To bring about a general consensus of opinion among the people in regard to the expenses of the fleet, to convince the citizens of the necessity for and utility of such expenditure, to bind closer the ties between the fleet and the country—in a word, to develop the naval sentiment in Germany—these were the chief reasons for the institution of the German Navy League.

Organized on April 30, 1898, in December of that year its membership was 14,252; but it included 51 associations which were cooperative with it, having a membership of 64,400, which brought the total up to 78,652. It had attracted representatives from 374 cities, 384 villages, and 16 undefined localities in the German Empire. A review of its finances showed that every member had contributed an average of 80 cents to the common fund.

On October 1, 1899, the actual members of the league numbered 68,426, and on November 8, 81,296, an increase of 2,870 in a little over a month.

On January 15, 1900, the membership was 101,546, 9,500 having joined since December 15. In addition, there were affiliated with the league 23 naval clubs, having 2,460 members; 89 military clubs, with 101,044 members; 88 miscellaneous clubs and societies, numbering 49,386 members; and 86 joint stock companies, etc., represented by 86 delegates, bringing the grand total of those who were directly or indirectly members of the league to 254,522.

At a meeting of the league on January 24, 1901, the president announced that during the year 1900 the membership of the league was increased from 246,967 to 566,141 and the number of branches from 286 to 1,010. The total expenses of the league for the year were 939,251 marks ($223,541.74).

As early as February, 1899, branches of the league had been organized abroad at the following places: Alexandria, Rotterdam, Habana, Constantinople, Trieste, Levatore, Santos, San Juan de Porto Rico, Lisbon, Bahia, Ciudad Bolivar, Mexico, Cairo, Johannesburg, Colombo, Naples, Jerusalem, Florianapolis, Jaffa, Bombay, and Chile.

PUBLICATIONS.

The league publishes a Yearbook for Germany's Maritime Interests. The following editorial from a British paper gives a good idea of this work:

> Our readers are aware that we have for some years attempted, as occasion offered, to arouse them to a sense of the tremendous significance of the growth of the German navy and of the popular and national movement by which the expansion of the German fleet is promoted. The Yearbook for Germany's maritime interests is, however, a surprise even for those who have paid some attention to this movement. The existence of a German Navy League is known, of course—at any rate to the members of the British Navy League, of which it was in the first instance a copy—but we doubt whether anyone in this country, either at the Admiralty, in the Navy League, or outside of them both, has yet realized how deep rooted, how widespread, and how well organized is the German national agitation for a great navy. The Yearbook is a popular treatise, written with scientific accuracy, for the purpose of explaining to the German public not merely how the German fleet is progressing in comparison with those of other powers, but how the influence of navies in the fate of nations is growing from year to year. First come a dozen political and historical essays to illustrate the use of navies, then a second dozen papers on the economical

and technical aspects of naval and maritime industries, and, lastly, ten statistical papers. The volume gives its readers a liberal education in regard to such questions connected with the navy as the stay-at-home citizen can master. In the first section are historical sketches of the naval histories of Great Britain, of Holland, of the Scandinavian states, and of Venice; an essay on the laws of war at sea; and a very remarkable review of the recent expansions of Great Britain, the United States, Russia, and France.

Ueberall was, until the beginning of the present year, a monthly magazine of about thirty pages. Now, it is issued weekly, and is practically of the same size. The general idea of the paper is the same as the *British Navy League Journal*, but it is larger and more complete.

The official organ of the league may be said to be *Die Flotte* (The Fleet). This paper contains all reports of the league, and is forwarded to all members free of charge.

Another popular pamphlet issued by the league is *Arbeiter und Flotte* (Workmen and the Navy). This pamphlet has perhaps produced the best results for the propaganda of the league. Seven million of these pamphlets were issued, so that it would be difficult to find a German subject who has not had one pass through his hands.

The objects which this publication has in view may be deduced from the following headings:

Is Germany able or not to take part in world politics?
With which countries has Germany most commerce and traffic?
By what means is it possible for a strong state to ruin a weaker one commercially?
In this century the tendency of nations is for the strong to become stronger and the weak weaker.

It might appear to some that chapters so headed would contain matter beyond the comprehension of the ordinary reader among the masses. But it is not so. The articles are written to appeal to the mass of German subjects, and the language is such that this object is accomplished.

To return to the work of the league. Prizes are given in the public schools for the best essays on naval subjects, and an effort is being made to introduce some references to the naval power of the Empire in the school books in common use. Lectures are given throughout the country, and models of battleships are exhibited in all inland towns. Torpedo boats and other small craft are sent up all navigable rivers in the Empire, to be seen by the people.

To quote an article in the *British Navy League Journal:*

> One can acquire an adequate conception of the activity of the German league by learning that at its offices at Berlin 40 men are employed in winter and 30 in summer; that every day about 300 letters and 150 parcels are posted; that the conferences held by its propagandists throughout Germany reach the enormous figure of 3,000; that 5,000 mutoscopic views have been exhibited in various railway stations of the Empire, and that even restaurants and bars have been opened where the attendants are dressed as sailors, and the walls hung only with pictures relating to maritime subjects. The league has laid even jewelry under contribution for its propaganda.

Special articles of jewelry have been made specially for the league; i. e., scarf pins, trinkets, earrings, bracelets, and necklaces have been sold in quantities by German jewelers, who pay the league a percentage on the right of reproduction.

And thus, even to the very head of the great continental Empire, the people—who have never seen the seacoast, who, till a few years ago, had never even dreamed of a great naval power for Germany—now speak with enthusiasm and assurance of battleships and cruisers, of military and naval maneuvers, both of which they follow with equal interest, and pride themselves as a nation on their great maritime power, which is to be the strongest bulwark of a still "Greater Germany."

The German Navy League can therefore fully claim to have accomplished its object; to the State is due the credit of having created a powerful fleet; to the league the credit of having increased that power and of having rendered it national.

FRANCE.

The French Navy League, inspired by and modeled after the British Navy League, was organized early in 1899. In publishing the first lists of adherents to the league, Senator Landry, referring to the British review at Spithead in July of 1897, wrote:

> An eyewitness to the marvelous results obtained by the English Navy League, my great desire was that my country should possess a similar organization. Since then I have become more and more convinced that much good can be done by the French league. Thanks to the support which will come from all sides, the founders of the league will attain the object they have in view, which is to create a maritime movement in the country. However persevering and well directed the efforts of the Government may be, they require to be supported by Parliament. But Parliament, and with it public opinion, need special initiation into naval matters. It is the league which will preach the good word, spreading abroad the indispensable knowledge of naval matters to citizens whose country is bathed by two seas, and whose growing colonial empire would suffer an eclipse if it had not a powerful navy.

In the appeal to the public made by the committee of organization the aims of the league are more clearly indicated. They are divided under eight heads:

1. The development of the navy.
2. The development of the merchant marine.
3. The development of the fleet of auxiliary cruisers.
4. The development of submarine telegraphic communication.
5. The development of ship canals in France.
6. The drawing attention to the naval exhibition of 1900.
7. Organization of naval fêtes in France and her colonies, and the commemoration of great naval anniversaries.
8. Promotion of mutual-aid societies for sailors.

The league received the support of the Government in the following letter from M. Lockroy, minister of marine, addressed to all maritime prefects, general staff officers, and commanders of vessels:

> GENTLEMEN: There has just been formed, under the title of the Ligue Maritime Française, a society the objects and regulations of which were published in the *Moniteur de la Flotte* on January 29, 1899. In order to encourage this association, which might have in France an influence as great as other similar societies have in their respective countries, I have the honor to inform you that I authorize the officers and

men of the navy to join the same and to further its interests, as the British Government has done in the case of the Navy League, and the Italian Government for the Lega Navale. Will you be kind enough to bring this decision to the notice of those whom it may interest, the official notification of which will be furnished by its publication in the *Journal Officiel* and the *Bulletin Officiel de la Marine.*

The constitution of the league, adopted by the general assembly on March 24, 1899, gives the organization and aims of the league:

CONSTITUTION OF THE FRENCH NAVY LEAGUE.

ART. 1. An association is formed under the title of "Ligue Maritime Française" for the development of the national navy and the merchant marine.

The headquarters of the society are established at 34, rue de Penthièvre, Paris.

ART. 2. The object of the association is to cooperate, to aid, and concentrate its efforts in the development of our means of naval defense; in the improvements and general interests of our merchant marine.

ART. 3. The Ligue Maritime Francaise shall work with this object in view by every means of dissemination and propaganda, by lectures, pamphlets, and books, by the voice of the press, and the formations of local committees.

ART. 4. The association is composed of all persons adhering to the present statutes, who will be divided as follows:

1. Charter members.
2. Adherent members.
3. Affiliated societies and associations.

The founders are composed of two classes of subscribers—

1. Persons who originally joined the Ligue Maritime, before the general assembly took place, and who have paid in an assessment of at least 10 francs as a life membership.

2. Persons who joined after that general assembly and pay a yearly assessment of at least 10 francs, or who will make a single final payment of a sum not less than 200 francs.

The adherent members are composed of those French subscribers paying a minimum annual assessment of 3 francs.

Ladies and young men may become members of the above two classes. Subscribing minors must obtain the consent of their parents or guardians.

Affiliated associations or societies are composed of chambers of commerce, naval clubs, industrial, commercial, and agricultural societies, gymnastic or military educational associations, literary or artistic societies, etc.

Their collective assessment is fixed at 5 francs as adherents, and at 20 francs as charter members.

ART. 5. Every member of the Navy League takes upon himself the duty of bringing new members into the league.

ART. 6. The association is governed by a committee. The committee is composed of 40 members. They are appointed for four years, one-fourth being elected every year. The retiring members are eligible for reelection. The committee fills up vacancies. Its action is subject to the approval of the next following assembly. In the election of members of the committee, vote by letter is admitted. A secretary is attached to the committee.

The retiring members in the first three years are designated by lots.

ART. 7. The bureau or executive committee is composed of the honorary presidents, the president, the five vice-presidents, a secretary-general, a treasurer, and two assistant secretaries-general.

ART. 8. The committee meets monthly, and as often as judged expedient by the president he announces the admission of associates, charter members, or adherents, and exclusions, as the case may require. A regular general meeting shall be held in the second quarter of the year. The committee may call an extraordinary general meeting.

ART. 9. Special regulations are made for the interior administration and the details necessary for the proper observation of the constitution. The rules are made by the bureau, who may change them with the approval of the committee.

ART. 10. In case of dissolution the assets of the association shall be devoted to maritime philanthropic works.

ART. 11. The decisions of the general assemblies are based upon a majority of votes cast by the members present, except in the case of modifications in the constitution, when a two-thirds majority of the members present will be necessary.

ART. 12. The Navy League shall avoid all religious and political discussions. It devotes its energies exclusively to the increase and improvements, necessary and rational, of our naval forces and merchant marine in the interests of the security and glory of the country.

ART. 13. No modifications in the present constitution shall take place without previous notice to the competent authorities.

On April 10, 1899, the membership of the league was 1,065. Total receipts of the league, 14,400 francs ($2,779.20), and the total expenditure, 5,095 francs ($983.34).

In April of 1901 the membership of the league was between 4,000 and 5,000.

The league has decided to publish a book for the purpose of propagating its ideas. The book is entitled *La Marine Militaire*, written by a lieutenant in the navy, and its object is to acquaint the people generally with naval matters.

ITALY.

The Lega Navale Italiana (Italian Navy League) was organized in 1897, but the constitution was not finally approved until May 20, 1900, so that the league has only been actively organized for a little over a year.

The object and organization of the league, with details of its work, are given in the constitution:

CONSTITUTION OF THE ITALIAN NAVY LEAGUE.

ART. 1. An association has been formed under the name of "Lega Navale Italiana."

ART. 2. The object of the association is to exercise a beneficial action in favor of the development of our naval and mercantile marine, to extend in Italy the spirit of the navy and the love of things concerning the sea, and to favor all measures tending to improve Italian navigation.

ART. 3. The association will endeavor to attain its aim by an active propaganda in the press; it will plan special trips to visit the great maritime cities and the great ports of commerce, and to this end it will furnish special facilities for the members; it will establish competitions, hold meetings, etc., and take all the initiatives useful to the development of maritime interests in all their forms.

ART. 4. Its official acts will be published in the monthly bulletins of the association, which will be sent to all members. The review *La Lega Navale* is authorized to print the official acts of the association.

Art. 5. The association has its headquarters at Spezia, and comprises an indefinite number of sections and subsections constituted in other cities of Italy. Over 50 members constitute a section and less than 50 members a subsection. In no case can the membership be less than 25.

Art. 6. The association is managed by a central committee at Spezia. The sections and subsections, as regards their own rules and administration, are autonomous, but all must, however, be subordinate to the constitution of the Navy League.

Art. 7. The sections and subsections will contribute to the general funds of the association, paying to headquarters one-fourth of their income from whatever source.

Art. 8. This amount, together with the direct contributions to headquarters, will constitute the fund to be administered by the central committee. The annual accounts will be made public.

Art. 9. The members of the Italian Navy League are distinguished as charter members, active members, meritorious (benemeritus) members, and honorary members. Charter members are those who are members by virtue of the original constitution, or who joined as active members before the 20th of May, 1900. Active members are those who join the association after May 20, 1900, paying annual dues of 3 lire, whether they are inscribed at headquarters or at any of the sections or subsections of the Navy League. The full annual dues must be paid in advance upon the act of inscription for the time from the date of inscription to the 31st of December of the current year and before the 20th of January of every year thereafter. Meritorious members are all those who have paid to the association a sum of not less than 100 lire; they will be exempt from the payment of the annual dues of 3 lire, and will be entitled to the monthly bulletin containing the official acts of the association. Honorary members are those persons who by special merit in work for the association or for the marine have made themselves worthy of such honor. Such members are elected by the general assembly.

Art. 10. Only those members who request their resignation from the secretary of the headquarters or of the section or subsection where they are inscribed not later than the end of November will be considered as having resigned.

Art. 11. Ladies may belong to the association with the same rights as other members.

Art. 12. The central committee is composed of 20 members, elected by the general assembly for three years, one-third to be elected each year. The president and the secretary-general are elected for three years, and are included in the 20 members of the central committee. The retiring members in the first and second year are designated by lot, and they are eligible for reelection.

Art. 13. The central committee is divided as follows: The president, two vice-presidents, one secretary-general, two assistant secretaries-general, one treasurer, two accountants, and eleven directors. The presidents of the sections, or some one delegated by them, act ex officio on the central committee, and may be present at any meeting.

Art. 14. The central committee provides for the carrying out of the objects of the league, it aids and advises the work of the sections and subsections, administers the funds of the association, and carries out the plans of the general assembly. It convenes annually at times to be stated by the general assembly.

Art. 15. The general assembly shall be formed of the members of the central committee and of delegates from the sections and subsections. Each section shall send to the general assembly a delegate for each 50 members, and each subsection shall send one delegate. There shall in no case be more than five delegates for any one section.

Art. 16. The general assembly is called at two months' notice, and the orders of the day, with the propositions of the council, will be sent to the sections and subsections by the central committee. The propositions of the sections and subsections must be sent to headquarters at least one month before the day fixed for the general assembly, and they will immediately be communicated to the various sections by means of a supplement to the order of the day. The propositions of the central committee will have precedence.

ART. 17. The general assembly constitutes a quorum whatever the number of the members present and a majority of votes decides.

ART. 18. The central committee may convene an extraordinary general assembly upon its own initiative.

ART. 19. Sections which have not sent their balance sheets to the central committee have not the right to send delegates to the general assembly.

ART. 20. A two-thirds majority of the members voting is necessary to amend this constitution or to change the laws passed by the general assembly.

ART. 21. The central committee will formulate rules for the government of the headquarters at Spezia.

PUBLICATIONS.

The official bulletin of the league is published monthly and gives all official acts of the league with accounts of meetings, etc.

"*Rivista*" is an illustrated fortnightly review corresponding to the German Navy League organ "*Ueberall.*" It contains current naval news with articles specially adapted to show the necessity of increasing the Italian navy.

As a means of propaganda illustrated post cards are issued with pictures of ships, etc., and bearing quotations such as "An increase of the navy is the best peace conference," and "Neptune's trident is the scepter of the world."

On November 24, 1900, the Italian Navy League and the German Navy League entered into an alliance to strengthen the political alliance of the two countries and to promote the principal common object of the two leagues, namely, "the development of maritime commerce and the increase of the naval strength of the two countries in order to contribute to the maintenance of universal peace." The object of the alliance is sought to be attained:

1. By an active interchange of views and ideas.
2. By the exchange of publications.
3. By sending delegates to the general assemblies of the league.

Some changes in the organization of the league have recently been proposed and are now under consideration, among others:

To transfer the headquarters of the league from Spezia to Rome; branches in maritime cities having an active membership of at least 500 to be known as *sedi* (seats, offices), other branches to be known as *sections* (in place of original designations of sections and subsections, art. 5 of the constitution); members to be divided into active, meritorious (*benemeriti*), and honorary members, the *benemeriti* members to include the charter members (art. 9 of the constitution).

THE SPANISH NAVY LEAGUE.

After several preliminary meetings during the latter half of 1900, the "Liga Marítima Española" was organized at a meeting held in Madrid on January 28, 1901. The constitution adopted at that time is substantially as follows:

Art. 1. The purpose for which the Spanish Navy League is formed is to promote, by every legitimate means of propaganda and influence, the maritime interests of the nation and to unite the efforts and aspirations of all maritime elements, without exception.

Art. 2. The headquarters of the Navy League shall be at Madrid, and the following may become members of the league: (1) Persons who join it individually by subscribing to its constitution and by-laws; (2) local and provincial branches which members of the league may desire to organize in other places, after having been approved by the central administration; (3) any associations or corporations now existing, or which may in future be formed, outside of or in Spain, that may desire to be represented in and cooperate with the league.

The by-laws will regulate such cooperation, the manner of taking part in elections and discussions, and the respective fees to be contributed by members toward the general expenses of the league. The ordinary fee for individual members shall be 3 pesetas (58 cents) a year. The by-laws will apportion the fees of associations and corporations which may join the league. The by-laws will further provide for the representation of the members at general and special meetings and for expression of their opinions.

Art. 3. The Junta Central (board of directors) of the league shall consist of a president of the league, a president of each of its sections hereinafter referred to, 24 directors, a general secretary, and an assistant secretary and treasurer.

The sections of the league shall be as follows:

1. *General matters.*—Persons connected with the political, military, or financial aspect of the maritime life of the nation.
2. *Navigation and commerce.*—Shipowners, freighters, consignees, and merchants.
3. *Personnel.*—Naval officers, engineers, and others in the navy.
4. *Construction and equipment.*—Persons employed at naval arsenals, dockyards, factories, and other industrial centers, manufacturers of ammunition and of various kinds of naval supplies.
5. *Fisheries and allied industries.*—Masters and owners of fishing boats, fishermen, and fish dealers, dealers in salt, salt meats, etc.
6. *Sports, instruction, propaganda, and life saving.*—Yacht clubs, nautical schools, life-saving societies, miscellaneous associations, and publishers.

Each of these sections shall have a president and four directors.

The president of the first section shall be vice-president of the league, and the affairs of said section shall be discussed and voted upon by the junta central.

Art. 4. All the offices in the junta central shall be held for four years, one-half being filled every two years, by election, in the manner provided for in the by-laws.

Any vacancies which may occur between elections shall be filled by appointments by the junta central.

For none of these offices shall habitual residence in Madrid be a necessary requirement.

The general secretary and the assistant secretary and treasurer shall not be subject to the foregoing regulations, and may be elected by the junta.

The members of the junta elected at the organization meeting shall not hold their offices for more than two years, unless reelected at the first general meeting.

Art. 5. The Naval League shall publish an official organ, which all members shall be entitled to receive.

The by-laws provide, among other things, that any branch of the league formed outside of Madrid may appoint a delegate, who, upon approval by the junta central, shall become a member thereof. All the offices in the junta shall be honorary and gratuitous, except those of secretary and assistant secretary. The official organ of the league shall be known as the "*Boletín Oficial*," and shall keep the members informed as to the work of the association.

There shall be three classes of members—charter members, ordinary members, and patrons. As charter members shall be considered all who join the league during the first year of its existence and pay an annual fee of 12 pesetas ($2.32). The annual fee of ordinary members is to be 3 pesetas (58 cents). As patrons are to be considered members who pay an annual fee of 120 pesetas ($23.20) or more. Besides, persons may become honorary members by a donation to the league of 1,000 pesetas ($193) or more, or who, in the opinion of the junta central, incur the gratitude of the league by some other meritorious act. Branches of the league are taxed according to their membership, maritime associations and corporations according to the tonnage of their vessels, other corporations according to their capital stock. Life-saving societies are exempt from any fees.

General meetings of the league shall be held annually, in May or June. Special meetings may be called at any time by the junta central, giving at least two weeks' notice and stating the objects for which such meetings are to be held.

A three-fourths majority of the members of the league shall be nceessary in order to amend the constitution or by-laws or to dissolve the league.

The objects of the Naval League are stated to be as follows:

1. Instructive propaganda of naval matters in order to make the movement of maritime rehabilitation more general and to spread among the people the education and spirit which it lacks.
2. The encouragement of fisheries and all allied industries and the instruction of the classes engaged therein.
3. The study and development of every means for rendering commercial navigation useful and profitable.
4. Encouragement and development of naval construction and allied industries.
5. Development of the Spanish merchant marine to its fullest extent and education of its personnel.
6. Increase and diffusion of maritime sports of every kind.
7. Development of the manufacture of naval material.
8. Rehabilitation of the navy and organization of the maritime defense of Spain in accordance with the political and financial needs of the country.
9. Popularization of the history and literature of the navy and commemoration of of great achievements of the navy and of its heroes.
10. The bringing together of all persons engaged in maritime pursuits.

It was decided to place the Naval League, as soon as its organization had been fully completed, under the protection of the King and to enter into immediate correspondence with the naval leagues of England, Germany, France, Italy, Belgium, and Portugal.

In a circular letter dated February 15, 1901, the junta central called upon all members of the league to set forth in writing and forward to the secretary of the league prior to March 31 their opinions as to what would be "expedient and useful for the development and welfare of maritime Spain," the object being for the junta central to draw up from the observations and suggestions received, previously arranged by the secretary, a list of questions to be submitted at the meeting of the league in May as the subject of its first deliberations.

VI.

THE NAVAL MANEUVERS OF 1900.

By Lieutenant Orlo S. Knepper, United States Navy,
Staff Intelligence Officer.

While the following report of various naval maneuvers is substantially correct, it must be remembered that the data is all from press reports and other unofficial sources.

SECTION I.

ENGLAND.

The English naval maneuvers were carried out from July 10, 1900, to August 3, 1900, the actual period of hostilities lasting only ten days, namely, from July 24 to August 3.

The following order, issued by the Admiralty on July 10, gives the general idea of the maneuvers, with the composition of fleets, rules and regulations, etc.:

Object.

The principal object of the maneuvers is to obtain information relative to the working of a fleet, which is composed of vessels of all classes, and is fighting for the command of the sea.

The most suitable distance at which to establish a temporary base for a squadron watching a hostile fortified port is a subsidiary question.

The power which cruisers may or may not possess of hunting down and driving torpedo craft into port is another important point.

General Idea.

A fleet (B) is divided into two squadrons: B1 at Milford, B2 at Lamlash.

A hostile fleet (A), inferior in battleships to (B), is also divided into two squadrons: A1 at Berehaven, A2 at Lough Swilly.

A hostile reinforcement (A3), which will make A1 + A2 + A3 nearly equal to B1 + B2 in battleships, is expected from the Mediterranean.

The whole of Ireland is hostile territory and belongs to (A). The whole of Great Britain from Cape Wrath to Lands End, the Isle of Man, and the Scilly Islands belong to (B).

The fleet (B) has destroyers.

The hostile fleet (A) has torpedo boats, supported by fast small craft.

The following ports are fortified and will be placed in a state of defense:

In Great Britain: Milford Haven.

In Ireland: Berehaven, Queenstown, Lough Swilly.

All other ports, including Lamlash, are unfortified.

Each fleet will try to obtain command of the sea, that is to say, will endeavor to defeat the other, to shut him up in his ports, and especially to clear the sea of his torpedo craft.

Rules and Regulations.

The following are the rules and regulations to be observed during the maneuvers:

The maneuver field is bounded on the west by the twentieth meridian; on the north by the sixtieth parallel; on the east by the fifth meridian as far as Cape Wrath, by the west coast of Great Britain, and by the meridian of the Lizard Head from that point to the southward; on the south by the forty-fifth parallel.

The signal stations marked on the special chart issued with the instructions for the distribution of intelligence will alone supply information during the maneuvers.

As soon as the whole of the ships and vessels composing the two fleets, together with the destroyers and torpedo boats, have arrived in port, a telegram will be sent from the Admiralty naming the hour when hostilities are to begin.

No vessel of any class is to put to sea before the hour named for the beginning of hostilities.

Battleships are to complete with coal on arrival at their base ports before again putting to sea.

All battleships are to be considered equal in fighting power to the *Majestic.*

No rules setting forth the conditions under which ships will be put out of action will be issued. Each case must be decided by the umpires on its merits on the basis of what would be probable in war.

When two or more ships come into action the beginning of the engagement is to be marked by the firing of a gun by one of the ships engaged. During the engagement single guns are to be fired at five-minute intervals by one ship on each side.

When either side considers that he has beaten the other he should signal "Propose reference to umpires." If the other agrees to the reference the action is to cease. If the other does not agree the action may continue, but not for more than a reasonable time, which is to be determined by the senior officer present. A reasonable time under ordinary conditions would be one hour in the case of battleships, cruisers, and torpedo gunboats, and half an hour in that of destroyers and torpedo boats.

When reference to the umpires has been settled, the senior officer present is to determine what ships on either side are to proceed into port to await their decision, pending which the ships detached are to be considered out of action. The senior officer present must take care to select as far as possible equally from both sides.

If a ship is undoubtedly torpedoed, or manifestly overpowered by a much superior force, the senior officer present may take the responsibility of temporarily putting such ship out of action and ordering her into port for the decision of the umpires. In this case it will not be obligatory to order into port a ship from the opposite side.

Ships put out of action can take no further part in the maneuvers, but must return to one of their base ports—Milford, Lamlash, Berehaven, or Lough Swilly—flying the Blue Peter at the fore. They are to select a route as far as possible clear of the scene of operation, and are strictly enjoined not to communicate any information to the ships on either side which they may meet on the way.

Colliers, after reaching Milford, Lamlash, Lough Swilly, Berehaven, or Queenstown, are open to capture; the captors can use the coal in them.

Colliers are not to be interfered with after they have discharged their cargoes.

Signal stations are not open to attack by landing parties.

As the 18-inch torpedo can not be fired at a ship in a peace exercise, a destroyer is to fire a blue light by night or blow her whistle by day at the moment when the torpedo would be discharged, the tube being trained and all adjustments made as if actually firing.

Torpedoes fitted with collapsible heads may be fired at battleships and cruisers, but not at torpedo gunboats, destroyers, or torpedo boats.

Torpedo boats are not to paint out their numbers.

As it is assumed that the command of the sea is disputed, care should be taken not to expose vessels needlessly to fire from forts.

LIST OF SHIPS.

Fleet A.

A1.

Majestic.
Repulse.
Dreadnought.
Sultan.

A2.

Prince George.
Resolution.
Edinburgh.
Conqueror.

A3.

Magnificent.
Jupiter.
Hannibal.
Mars.

Cruisers.

Diadem.
Blake.
Edgar.
Gibraltar.
Immortalité.
Gladiator.
Talbot.
Furious.
Naiad.
Sirius.
Apollo.
Retribution.
Phœbe.

Fleet B.

B1.

Alexandra.
Colossus.
Rodney.
Howe.
Collingwood.
Camperdown.
Hero.
Thunderer.
Superb.

B2.

Sans Pareil.
Nile.
Trafalgar.
Benbow.

Cruisers

Ariadne.
Blenheim.
Hawke.
St. George.
Galatea.
Vindictive.
Minerva.
Cambrian.
Rainbow.
Melampus.
Andromache.
Medea.
Medusa.

Flotillas.

Pactolus Perseus Pioneer Spanker Sheldrake Seagull Skipjack Jason Hecla	42, 49, 50, 59, 66, 71, 76, 77, 81, 82, 83, 84, 63, 64, 68, 74.
Mersey Prometheus Speedwell Sharpshooter	45, 52, 53, 55, 57, 58, 85, 86.

Brilliant Alarm Renard Leda Circe Jaseur	Portsmouth and Chatham divisions of destroyers (16 in number).
Severn Antelope Gleaner	Devonport division of destroyers (8 in number).

INSTRUCTIONS RELATIVE TO UMPIRING.

The following officers are nominated to act as umpires: Vice-Admiral Sir Compton Domvile, K. C. B., Rear-Admiral C. C. Penrose Fitzgerald, Rear-Admiral A. D. Fanshawe.

Lieut. Gen. J. F. Owen, R. A., is nominated by the war office to act as military umpire to decide, jointly with the naval umpires, claims arising between the land defenses and the ships.

They will meet at the Admiralty, Whitehall, where all claims and statements for their consideration should be sent, addressed to the "Secretary of the umpires." Claims, etc., are to be sent in as soon as possible after the events to which they refer on the form provided for the purpose. They should be accompanied by extracts from the ship's log or signal log, by track charts when necessary, or by other documentary evidence likely to assist the umpires in arriving at a decision. Claims, etc., sent by telegraph must be followed by the same claim, etc., on the proper form, sent by the first post.

The decisions of the umpires are final.

Umpires will not make known their reasons for arriving at a decision.

No reference will be made by them to the Admiralty before arriving at a decision.

The decisions of the umpires will be communicated to the Admiralty as soon as possible after they have been arrived at, in order that, if desirable, they may be made known to the senior officer on each side.

Should the Admiralty desire to communicate with the fleets during the progress of "hostilities," and their instructions be conveyed by a ship attached to either of the opposing forces, or by any other ship, such a ship is to display the signal AKH.

It will thus be known that she is acting under Admiralty orders, or is about to deliver dispatches or telegrams, or to signal orders received from the Admiralty, and the respective admirals and senior officers are to take the necessary steps to insure that the orders so communicated are forwarded and acted on without delay.

If the commanding officer of one vessel sights another flying the signal AKH, he is at once to close her so as to place himself at a convenient distance for communicating by signal, should it be necessary.

General Orders and Instructions.

A partial mobilization of the fleet for maneuvers will take place this year. The vessels mobilized will be attached to the Channel and Reserve squadrons. They will assemble as soon as ready under the orders of the flag officers in command at Portland and Torbay, respectively, and will be formed in two fleets, to be known as Fleet A and Fleet B, respectively.

At the time appointed the main fleets will proceed to sea for the usual preliminary cruise, during which the ships will be exercised and anchored at the discretion of the admiral in command.

Two flotillas, composed of cruisers, torpedo gunboats, and destroyers, will be attached to B fleet.

The vessels belonging to these two flotillas will assemble at Torbay and will be organized thus:

Severn, two torpedo gunboats, Devonport division of destroyers.
Brilliant, five torpedo gunboats, Portsmouth and Chatham divisions of destroyers.

They will then proceed as follows:

Severn and flotilla to Lamlash;
Brilliant and flotilla to Milford Haven;

where they will be exercised and will coal, care being taken that all are complete with coal before the beginning of hostilities.

Two flotillas, composed of cruisers, torpedo gunboats, and torpedo boats, will be attached to A fleet.

The vessels belonging to these two flotillas will assemble at Devonport and will be organized thus:

Pactolus, *Perseus*, *Pioneer*, *Hecla*, five torpedo gunboats, Portsmouth and Chatham divisions of torpedo boats.

Mersey, *Prometheus*, two torpedo gunboats, Devonport division of torpedo boats.

They will then proceed as follows:

Pactolus and flotilla to Berehaven;
Mersey and flotilla to Lough Swilly;
where they will be exercised and will coal, care being taken that all are complete with coal before the beginning of hostilities.

Any portion of the Berehaven flotilla can be sent thence to Queenstown, provided that it arrives there and is completed with coal before the beginning of hostilities.

At the termination of the preliminary cruise the ships forming Fleet A will be formed into three divisions, and those forming Fleet B into two divisions. They will then be detached to the following base ports: A1 to Berehaven, A2 to Lough Swilly, A3 to a rendezvous, B1 to Pembroke, B2 to Lamlash.

The order to begin hostilities will be sent on the day on which the ships arrive at their base ports.

The period of active operations will last ten days. On the conclusion of the maneuvers the ships and vessels will proceed to carry out target practice, separately in the case of the mobilized ships, ample time being allowed for the careful performance of the practice; in the case of other ships, separately or in company, at the discretion of the admiral in command.

Only one-half of a quarter's allowance of ammunition is to be expended from the heavy, light, R. F., and machine guns of the mobilized ships.

A full quarter's allowance of ammunition may be fired from destroyers and torpedo boats if considered desirable by the officer commanding the flotillas.

Only such naval stores as are necessary to keep destroyers and torpedo boats efficient during the maneuvers are to be embarked in the depot vessels *Hecla*, *Mersey*, *Severn*, *Brilliant*, during the mobilization. No ordnance or torpedo depot stores will be required.

A copy of the ship's and signal log of every vessel taking part in the maneuvers, commencing twelve hours before and ending twelve hours after the active operations, is to be sent to the Admiralty with the report of the admiral in chief command of each fleet.

MOBILIZATION.

As early as the first week in July the torpedo-boat flotillas at Portsmouth, Plymouth, and Chatham were ready to put to sea and commenced their preliminary exercises. A large number of other vessels which, as a rule, are not used for maneuvering purposes were placed in commission. Strict secrecy was maintained as to the particulars of the maneuvers prior to the beginning of the same, the Admiralty alone being in possession of detailed information.

From a statement of the Admiralty, 49 ships and torpedo boats were specially commissioned for the maneuvers, and in all 115 vessels, with a personnel of 30,000 officers and men, took part. Of the coast guard embarked for the maneuvers there were 45 officers and 1,711 men, and of the royal navy reserve 35 officers and 390 men.

Portsmouth.—The following ships were commissioned on the morning of the 10th, the torpedo boats having been commissioned prior to that date:

	Displacement.	Complement.
Sultan (third-class battleship)	9,290	660
Hero (third-class battleship)	6,200	335
Ariadne (first-class protected cruiser)	11,000	677
Gibraltar (first-class protected cruiser)	7,700	520
Gladiator (second-class protected cruiser)	5,750	450
Naiad (second-class protected cruiser)	3,400	273
Brilliant (second-class protected cruiser)	3,600	273
Medea (third-class protected cruiser)	2,800	216
Hector (torpedo depot ship)	6,710	277
12 torpedo boats (approximately)	900	180
Total	57,350	3,861

The gunnery and torpedo schools on the *Excellent* and *Vernon* had been closed, and the men from them for the maneuvers had joined the depot the night before.

All ships commissioned at Portsmouth left for Spithead the same day for their steam trials.

Devonport.—At Devonport the following ships were commissioned on the 10th:

	Displacement.	Complement.
Rainbow (second-class protected cruiser)	3,600	273
Apollo (second-class protected cruiser)	3,400	273
Phoebe (third-class protected cruiser)	2,575	190
Conquerer (third-class battleship)	6,200	335
Sirius (second-class protected cruiser)	3,600	273
Retribution (second-class protected cruiser)	3,600	273
Blake (first-class protected cruiser)	9,000	590
Edgar (first-class protected cruiser)	7,350	574
Andromache (second-class protected cruiser)	3,400	273
Talbot (second-class protected cruiser)	5,600	437
Cambrian (second-class protected cruiser)	4,360	318
Speedwell (gunboat)	735	91
Sharpshooter (gunboat)	735	91
Total	54,155	3,991

The ships all left the harbor in the afternoon for their steam trials, and the next day proceeded to their rendezvous.

Chatham.—The following ships were commissioned at Chatham:

	Displacement.	Complement.
Dreadnought (second-class battleship)	10,820	440
Superb (second-class battleship)	9,170	600
Edinburgh (second-class battleship)	9,420	396
Hawke (first-class protected cruiser)	7,350	544
Immortalité (first-class protected cruiser)	5,600	497
Blenheim (first-class protected cruiser)	9,000	590
Mersey (second-class protected cruiser)	4,050	325
Perseus (third-class protected cruiser)	2,135	225
Pioneer (third-class protected cruiser)	2,200	225
Prometheus (third-class protected cruiser)	2,135	225
Medusa (drill ship)	2,800	216
Four torpedo boats (approximately)	300	60
Total	64,980	4,343

Total number of vessels commissioned.

	Number.	Displacement.	Complement.
Portsmouth	21	57,350	3,861
Devonport	13	54,155	3,991
Chatham	15	64,980	4,343
Total	49	176,485	12,195

OFFICERS IN COMMAND.

Fleet A.—Vice-Admiral Sir Harry H. Rawson, commander in chief; flagship *Majestic.*

Squadron A3.—Rear-Admiral Albert B. Jenkins; flagship *Magnificent.*

Fleet B.—Rear-Admiral Sir Gerard H. U. Noel, commander in chief; flagship *Alexandra.*

Squadron B2.—Rear-Admiral J. L. Hammet; flagship *Sanspareil.*

HOW THE EXERCISES WERE CARRIED OUT.

The two squadrons of Fleet B assembled at Torbay. In doing so some accidents occurred in connection with coaling, etc. It is admitted that these were due partly to lack of training on the part of those who had charge of the men at work, and that since the disappearance of masts and sails sufficient care has not been bestowed upon training the men to constant watchfulness, alertness, and self-reliance. * * *

Fleet B, with the battleships and cruisers in squadron formation, left Torbay on July 16, at 10 o'clock a. m., shaping its course westerly, and despatched the *Medusa* to Plymouth with the sick and prisoners. During the next few days over four hours daily were devoted to evolutions of the battleships and cruisers, steaming at the rate of 10 knots.

As the two squadrons maneuvered separately, at a distance of from 3 to 5 miles from each other, there were good opportunities for having all hands on deck and at quarters for battle and thus familiarize them with training the guns upon fleets. During the forenoon of the 18th the vicinity of the coast and dense fog made it necessary to desist from tactical evolutions, and Admiral Noel dispatched the *Cambrian* to reconnoiter the coast of Cardigan Bay. In the meantime one case of scarlet fever and two cases of measles had developed on board the ships of Fleet B and the patients were taken ashore to the hospital. On the whole, the state of health on board was good; there were in the whole fleet, including the destroyers, only 2.5 per cent sick, which amounted, however, to 332 hospital patients—about enough to man a second-class cruiser.

While under way, exercises and drills were kept up day and night. In the dark two small electric lights were used on the guns, a white one in front and a red one in the rear, both of them hooded.

On the morning of the 18th the fleet steamed through a dense fog where it was impossible to see a ship a cable's length off. Fog buoys were put overboard for the purpose of indicating to each ship the distance of the ship ahead. The *Alexandra* used Captain Fisher's towing target, which is of very simple construction and can be easily built with the resources on board. About 3:45 p. m., after an exercise in changing to different formations, Fleet B anchored in Cardigan Bay, off Cardigan.

The next morning, July 19, at 4:30 o'clock, Fleet B left Cardigan Bay, shaping its course for the Bay of Dublin. The battleships and cruisers carried out evolutions under way. They left Cardigan Bay in four columns, and during an evolution for complete inversion of the columns struck a dense fog. An evolution of this nature under such circumstances is by no means without danger, and the skillful manner in which it was carried out deserves recognition. The fleet was in four-column formation when it steamed into Cardigan Bay, and upon leaving it the signal for inversion was made, so that the ships which had been at the head would again become the leaders. The leaders decreased their speed, while the guides passed along the starboard side of their respective columns, the other ships following in their wake one by one. In this case the leaders had not decreased their speed sufficiently, considering the fog bank ahead of them, so that the guides upon taking their positions struck the dense fog, and the remaining ships followed their lead as best they could. In the course of the day the ships were enveloped in another fog bank for several hours, nearly at the spot where the *Iron Duke* rammed and sank the *Vanguard*. At times the outlines of the ships could be discerned at 300 yards distance. In Cardigan Bay the *Thunderer* had to have a piston ring exchanged, which was done during the night, so that the ship could accompany the fleet. Soon after the arrival in Cardigan Bay all of the larger boats, 120 in all, assembled at one end of the columns and engaged in a rowing race around the fleet, while the crews who had remained on board were carrying out gymnastic exercises. At 5 o'clock p. m. the fleet reached Dublin Bay and anchored off Kingstown, where the St. Georges Yacht Club was just holding its race.

Torpedo boats *64*, *71*, *76*, *77*, *81*, *82*, *83*, and *84* and torpedo gunboat *Seagull*, together with cruisers *Pactolus* and *Pioneer*, arrived at Queenstown July 18 and remained there until the night of the 19th. Cruiser *Severn* and torpedo gunboats *Antelope* and *Gleaner*, together with the destroyers *Panther*, *Leopard*, *Seal*, *Wolf*, *Leven*, *Locust*, *Thrasher*, and *Shark*, arrived at Lamlash July 17. Cruisers *Mersey* and *Prometheus* and torpedo gunboat *Speedwell*, together with torpedo boats *52*, *53*, *57*, *58*, *85*, and *86*, reached Buncrana the 17th.

In accordance with the general idea of the maneuvers, the hostile Fleet A was divided into three squadrons of four battleships each. A3 represented a reenforcement from the Mediterranean. Its position was thirty steaming hours at 15 knots from Admiral Rawson at Berehaven. Both fleets were to receive information from the time that A3 left Gibraltar, and would therefore be able to determine at what time the sailing orders would permit A3 to leave its rendezvous. But as none of the three squadrons received this information, it was to be assumed that, owing to the dense fog which delayed the arrival of B1 at Milford Haven by three hours, the plan had been hurriedly changed. But this did not explain another delay. Fleet B might reasonably assume that the remaining squadrons at Lamlash, Lough Swilly, and Berehaven would know shortly before midnight of the 24th that the hostilities were to begin at 2 o'clock a. m. of the 24th and cease at 2 o'clock a. m. of the 3d. But Fleet B, whose flagship was the *Alexandra*, did not receive this information until 6 o'clock a. m., four hours after the beginning of hostilities. Old Milford is the usual telegraph station for Milford Haven, and, upon his arrival on the evening of the 23d, Admiral Noel took the precaution of sending a telegram with instructions that all dispatches addressed to him should be sent to Old Milford, where boats and messengers were held in readiness. Unfortunately the military authorities had established a telegraph station for the maneuvers at South Stake Fort, and the telegram intended for Fleet B was sent there and reached the squadron in a mutilated form by signal, during a temporary clearing of the fog, at 3 o'clock a. m., and in complete form not until 6 o'clock a. m., after a boat had been sent after it.

If one of the objects of the maneuvers was to obtain information relative to the correct cooperation between the naval and military authorities in fortified ports, the faulty handling of this telegram was a bad beginning.

As soon as Admiral Noel learned positively that hostilities had begun, he promptly sent orders to the greater part of the cruisers and destroyers to proceed to Queenstown and Berehaven, respectively, and they started about 4 o'clock on the morning of July 24.

Measures were taken simultaneously to send the battleships to Dale-roads, near the entrance to the Bay, and they proceeded there singly in dense fog. Nothing could be seen, but by siren signals the ships reported when they had reached their destination. At 11:15 a. m. the whole squadron put to sea in a dense fog. As a precautionary measure, the harbor tug had been sent out to mark the middle buoy of the channel and give short signals with the steam whistle. As soon as the squadron had passed this buoy it increased its speed from 5 knots to 7.5, and at 2 o'clock p. m. it emerged from the fog and increased its speed to 10 knots. The *Hero* received orders to steam at her maximum speed, and for the remainder of the day the squadron maintained a speed of 11.5 knots. It consisted, outside of the nine battleships, of cruisers *Galatea*, *Rainbow*, *Medea*, and *Medusa*. The *St. George*, *Ariadne*, *Hawke*, *Vindictive*, and *Andromache*, together with 16 torpedo-boat destroyers, had been sent to sea to operate in the direction where the hostile squadrons were presumably to be found. With the rear-admiral and his four battleships were the four cruisers *Melampus*, *Cambrian*, *Minerva*, and *Blenheim*. These formed Squadron B2, and had left Lamlash, as the flagship learned by signals, at 2 o'clock a. m., immediately after the beginning of hostilities. They received orders to pass around the west of Ireland with Squadron B1. The *Severn* with its gunboats and flotilla of destroyers were the first to run out, in order to secure, as far as possible, a clear course for the battleship squadron. Their speed was estimated at at least 11 knots; Squadron B1 therefore had every reason to hurry in order to join them in the bay of Berehaven, as they were in danger of meeting two of the hostile squadrons. The fact that Squadron B2 had a start of twelve steaming hours over Squadron B1 had to be taken into account. It was for this reason that the slowest ship of the squadron was urged to her maximum speed. All the battleships of Fleet B belonged to the reserve, commonly known as the 10-knot squadron. That this speed was exceeded was considered a very good result, and, if the *Hero* and *Thunderer* had been allowed to remain behind, Squadron B1 would have attained a speed of 12 or 13 knots.

At 5:30 o'clock p. m. B1 began to receive information of minor skirmishes that marked the beginning of hostilities. Destroyer *Kestrel* joined the squadron and reported that she had been pursued from the coast by two hostile cruisers. Later in the evening the *Star* arrived and communicated with the flagship by megaphone and semaphore. Both of these vessels remained with Squadron B1, which was perhaps not a favorable circumstance in view of the fact that the coal supply of a destroyer is sufficient only for twenty-four hours steaming at 22 knots. In an emergency, it is true, they could take on coal from the other ships, since in favorable weather they steamed alongside of the latter at 30 yards distance, and the coal sacks could be conveyed to the bow of the destroyers by means of lines. Shortly after the arrival of these two vessels, B1 sighted the *Alarm* and *Leda* of Fleet B2 and learned that they had been captured off Kinsal Head by the *Diadem* and five cruisers, and, having been put out of action, were proceeding into port by order of the captain of the *Diadem*. Their loss was not much mourned, however, as these gunboats do not have sufficient speed to pursue torpedo boats. The cruiser *Andromache* also, after uninterrupted fighting with the *Diadem* for an hour and a half, reached the squadron. The *Diadem* did not appear to have made any claim to the victory, and it was therefore assumed that the distance was too great and that the Belleville boilers, with the latest type of which, with economizer, the *Diadem* was equipped, did not enable her to overtake the *Andromache*. Since July, 1898, when the *Diadem* was first put in commission, £4,200 have been expended upon her boilers, and her performances during the maneuvers were therefore looked forward to with special interest. (Of the remaining ships, the *Gladiator* and *Furious* of Fleet A and the *Ariadne* and *Vindictive* of Fleet B had Belleville boilers.) As Squadron B1 proceeded, it was joined by the *Brilliant*, which had been pursued by the *Diadem* and five or six of her companions. Squadron B1 continued to steam in close formation until 5 o'clock p. m., when the cruisers were sent from 3 to 6 miles ahead, two cruisers to take up positions 3 miles ahead of the flagship, one on each side, at an angle of 30 degrees, and again, 3 miles ahead of these, the remaining two cruisers, thus forming a semi-circle at the front, while leaving a clean field for the fire of the nine battleships on either side. The torpedo boats were sent off to one side, far out of the range of hostile ports. The admiral evidently trusted to the darkness to conceal his squadron, and the fact that the flagship alone was allowed to carry running lights seems to bear out this assumption. About sunset B1 distinctly discerned six hostile cruisers to the westward, apparently the *Diadem* with her four smokestacks and three large and two small cruisers. Having observed B1 from the northwest, they steamed off in that direction, and at 7:40 were lost from sight. Since Squadron B1 relied on the darkness, its line of conduct was to take notice of neither friend nor foe. But fire broke out in the sail room of the *Cambrian*, rendering it necessary to use flash signals in order to instruct her to leave the line. This accident, however, was without serious consequences, and did not result in a visit from any of the hostile torpedo boats, although they could be seen on the distant horizon, evidently endeavoring with their search-lights to discover B1 in order to make an attack upon its ships; but in this they were frustrated.

At 2:45 a. m., July 25, B1 observed hostile ships in a northeasterly direction, firing their guns. At 3 o'clock they were identified as the *Diadem* and the five cruisers sighted the evening before. The admiral of B1 did not care to have these ships come within range of the guns of his nine battleships, and therefore answered the *Diadem's* signal, marking the beginning of the engagement, only from the *Alexandra*. The entry on the log book of the latter concerning the battle is as follows: "3:20. Leader, a first-class cruiser, at 2,000 yards; the next at 3,000; the others between 3,000 and 4,000 yards. The *Diadem* opened fire at 3:24, the *Alexandra* at 3:49, and ceased firing in a few minutes. She signaled to the *Diadem:* 'We are of opinion that we have put you and another first-class cruiser out of action and propose reference to umpires.' The *Diadem* answered: 'We do not agree with you.'" This episode illustrates Admiral Noel's wisdom in having only one battleship carry running lights to allure the enemy, and also in having the broadside fire of his nine battleships in a single line, entirely clear of any vessels of his own. The admiral telegraphed with wireless apparatus to the *Diadem*, which was no longer in sight, to proceed into port and await the decision of the umpires.

During the night the *Sylvia* joined Squadron B1 and was dispatched in the morning of the 26th to carry information to the umpires as to the matter in dispute. She brought back the first news concerning the hostile battleships, having received it from a fishing boat. A1 had left Berehaven on the morning of July 17, steaming in a northwesterly direction. In war the source of information in hostile waters would have been unreliable, and constituted therefore only a problematic advantage. The enemy, on the other hand, had the advantage of inviolability of their signal stations.

At 1 o'clock p. m. Squadron B1 met B2 at 52° 10′ north latitude and 11° 34′ west longitude. The latter had wisely left its cruisers behind to obtain information in the vicinity of Lough Swilly. The destroyers *Star* and *Kestrel*, which had joined B1 after passing Queenstown, were sent out to coal and to carry the information that Fleet B was now complete. The *Star*, between 4 o'clock a. m. of the 24th and 10 o'clock a. m. of the 25th, had consumed two-thirds of her coal supply of 90 tons. This shows the great demands made on vessels of this class in war. As a rule, about two-thirds of them will be engaged in coaling or on their way to do so, and only one-third can be counted on to be off the hostile ports. Much depends, of course, on the distance of the ports.

As far as Fleet B was concerned, the question now arose as to what the enemy, Admiral Rawson, would do. With the exception of the evident endeavor on the part of the hostile cruisers to delay the advance of Fleet B, which endeavor, however, might also have arisen from a desire to drive the fleet toward the coast among the torpedo boats, Fleet B had no information concerning the enemy except that received from the *Sylvia.*

It was obvious that the first thing for Admiral Rawson to do was to unite his squadrons A1 and A2 as soon as possible, and this step had taken him northward on the 24th. But where was he now? This question might have been answered from the information as to the time when A3 had sailed from Gibraltar, but this information was lacking. Admiral Rawson's correct line of conduct appeared to be to utilize the advantages afforded him by his telegraph stations and cruisers, which would enable him to base his plans on the movements of Fleet B, while he would at the same time be saving coal. A few cruisers might be employed to carry information along his line by way of A3; or the admiral might designate a certain rendezvous for his fleet—for instance, Porcupine Bank, far out to sea—or his intention might be to pass around Fleet B to the northward while endeavoring to meet A3 to the southward about ten hours off his fortified ports of Queenstown and Berehaven; or he might select a position which would enable him to return to these ports, relying on the speed of A3; or, if cut off from his ports, he might relinquish assistance from A3 and engage at long range in an indecisive battle with Fleet B. If Fleet B had had an unlimited number of cruisers, its task would have been simple enough. It could have taken up a position at a central rendezvous and made arrangements for the rapid transmission of news by cruisers and wireless telegraphy; but the apparatus on the three ships equipped for wireless telegraphy were out of order and the cruisers were not nearly numerous enough. Fleet B therefore steamed to the westward on the assumption that Squadron A3 would approach it, and that it might meet with one of the other two hostile squadrons in that direction.

On July 26, at 2:30 p. m., Fleet B received the Admiralty's telegram notifying it that A3 had left Gibraltar on July 25, at 5 o'clock a. m., steaming at the rate of 10 knots, so that the latter squadron would not be able to reach the vicinity of Fleet B before the afternoon of Saturday, July 28. During the morning of July 28 the *Minerva* reported that she had sighted seven hostile battleships at 5 o'clock a. m., and two hours later the *Melampus* saw them in the same position, 55° north latitude and 10° 24′ west longitude. This was about 10 miles from B2's probable course. It was, therefore, almost certain that the two squadrons would pass each other during the night of the 27th, so that an especially sharp outlook on the part of the A cruisers would have resulted in an interesting chase.

At 1:30 o'clock p. m. the two squadrons of Fleet B united and commenced an animated search for the enemy. Destroyer *Seal* had in the meantime captured the enemy's tank ship at Lough Swilly.

On July 28 Fleet B received information that cruiser *Minerva* had been fired upon in a clear night by torpedo boats about 41 miles from Berehaven. As the *Minerva* can easily steam 16 knots, this seemed somewhat mysterious.

Fleet B prepared for battle, and Admiral Noel inspected the preparations. Heretofore the leaders had carried lights at night, but upon reaching the vicinity of Lough Swilly the lights on all the ships were done away with.

During the morning of July 28 the steering gear of the *Hero* refused to function. The same thing had happened on board the *Rodney* and *Thunderer* on the 26th, and these ships had therefore to interrupt the darkness surrounding the fleet by displaying the lights which signify that a ship has become unmanageable.

It was learned that the enemy claimed two second-class cruisers and nine destroyers as having been put out of action at Queenstown. According to the decision of the umpires, gunboats *Leda* and *Alarm* and destroyers *Spiteful*, *Kestrel*, *Locust*, *Thrush*, and *Wolf* had been put out of action. The *Violet*, which had sustained injuries during the fog, was replaced by another destroyer. Gunboat *Renard* and cruisers *St. George*, *Ariadne*, *Vindictive*, and *Hawke*, of Fleet B, and the *Diadem* and four other cruisers, of Fleet A, were still awaiting the decision of the umpires.

Sunday, July 29, was a day of rest.

The first period of the maneuvers had demonstrated anew the importance of correct information and of coal consumption. Fleet B had been fortunate enough to receive no false information. Yet the lack of cruisers to secure information for the battleships made itself felt here as in all previous maneuvers. Among naval authorities in England the opinion is that if cruisers are to consume too much coal—like the *Ariadne*, for instance, with her Belleville boilers, besides requiring large quantities for auxiliary purposes—the difficulties of the cruiser question will become even more serious. In this year's maneuvers the cruisers were not allowed off hostile ports prior to the beginning of hostilities, but had to remain in their own ports. The result has been instructive, for although four squadrons were out at sea, not one of them succeeded with its cruisers to establish touch with the others. Fleet A was at times able to make up for the lack of cruisers by making use of its coast signal stations. Another result was that even the information service of the superior Fleet B failed to establish touch with the enemy, and the question arises whether Fleet B, if instead of 13 cruisers, or one to each battleship, it had had two to each battleship, would not have succeeded in establishing touch. In the case in hand it seems probable that if Fleet B had had more efficient cruisers for scouting purposes the enemy's cruisers would not have succeeded, for instance, in dislodging the *Melampus*. It is true that the latter cruiser, after making a reconnoissance, succeeded in returning to her station, but two hostile cruisers drove her from it. The *Minerva* also was successful in her reconnoissance, but in both cases the information arrived one day too late, owing to the circumstance that Fleet B was on the lookout for A3. Fleet B was much hampered through the loss of its cruisers; but the control of the sea is decided by battleships, and the fleet therefore adhered to its intention to force the enemy to a battle, if possible. However, cruisers should observe hostile ports also before the beginning of hostilities and follow the enemy's squadrons like their shadows, so that fighting and blockading can be begun as soon as hostilities break out.

During the night of July 30 the *Trafalgar*, the fifth ship of the divisional column in line ahead of Fleet B, collided with the merchant steamer *King Orry*, the latter sustaining slight injuries.

On July 31 Fleet B received the adverse decision of the umpires as to its claim to the *Diadem* and another cruiser on July 25 off Fastnet. The *Diadem* and her companions, on the other hand, had put the *Renard* out of action. The total result was that Fleet A had lost two cruisers and one gunboat, Fleet B one cruiser, three gunboats, and five destroyers. The latter complained of having been fired upon by forts at impossible distances—the *Spiteful*, for instance, at 9,500 yards. The alleged putting out of action of the *Minerva* by a torpedo boat had arisen from a misunderstanding of the rules, which resulted, however, in Fleet B having to do without its cruiser for four days. Fleet A refuted the claim of the *Minerva* to three torpedo boats by proving that none of its torpedo boats had been near the *Minerva*. Fleet B, while cruising in the Irish Channel, repeatedly received information from its own observation personnel at signal stations, on board scouts, etc., that they had sighted the hostile fleet of battleships or cruisers, or even the enemy's torpedo-boat flotilla, for which they had mistaken Fleet B. Special stress is therefore being laid by British naval authorities on the necessity of paying more careful attention to the art of efficient scouting and affording better opportunities therefor.

As to the cruiser engagement of July 28 Fleet B now learned some particulars, though nothing satisfactory. The cruiser squadron of Fleet A consisted of the four first-class cruisers *Diadem*, *Gibraltar*, *Blake*, and *Immortalité*, and second-class cruiser *Naiad;* that of Fleet B of the three first-class cruisers *St. George*, *Ariadne*, and *Hawke*, and second-class cruiser *Vindictive.* As the mission of the B cruiser squadron consisted in scouting, it was not within the scope of its program to accept battle with a superior force. But the engines of the *Vindictive* were giving out, and so there was nothing left but to remain together, reduce the speed, and fight. Fortunately, the *Immortalité* (A's) was 4 or 5 miles behind, and it was not until the expiration of fourteen minutes that she was able to give any assistance to her companions, and of twenty-four minutes before she could assist them effectually. As both parties claimed the victory, the senior officer present sent all the ships to their respective ports to await the decision of the umpires. Fleet A appears to have sent four more ships to the same position. After the decision by the umpires, on July 31, the *Vindictive*, *St. George*, and *Ariadne* rejoined Fleet B. Fleet A lost the *Naiad* and the *Gibraltar*, the former considered to have been sunk, the latter to have been put out of action, while Fleet B lost cruiser *Hawke*, found to have been put out of action.

Particulars as to the engagement are wanting; they are in the possession of the umpires, who will not publish their report until ten months after the conclusion of the maneuvers, and then in a very short form.

Fleet B was inadequately supplied with information, and it happened several times that one of its own cruisers illuminated it for 10 minutes with her search-lights when its safety depended on the darkness and on the torpedo boats surrounding it. In daytime its cruisers sometimes followed the smoke of ships which proved to be peaceable merchant vessels. The number of cruisers at the rate of one per battleship is unquestionably inadequate, especially in view of the tasks of Fleet B.

On August 1, at 12:30 p. m., the *Blenheim* brought Fleet B the news that Fleet A had been sighted at 2:30 p. m. of July 31, 60 miles south of Queenstown, steaming on an east-northeasterly course toward the Irish Channel. The *Blenheim* and the *Cambrian*, which latter had been left behind for the purpose of observing the enemy, had had an hour's engagement with the *Blake*. The *Mermaid* also reported that she had sighted Fleet A steaming east-southeast of Ballycottin. These two reports gave rise to the hope that the enemy would be met with soon. It was unfortunate that Admiral Rawson had only 9 ships with him, having left the slower *Edinburgh*, *Dreadnaught*, and *Conqueror* behind. The course of action of Fleet B seemed quite correct. The signal stations and scouting cruisers had all been notified, and the cruisers and destroyers joined the fleet as it proceeded. A series of rendezvous designated by letters of the alphabet and forming a line around Ireland had been specified, so that it was not difficult for the vessels to join the fleet in time after being notified that the latter would reach a certain rendezvous at a given hour.

On August 2, at 11:10 a. m., the crusier *Minerva*, which was on the lookout, signaled to Fleet B that the enemy was in sight. The latter was 20 miles southeast of Tuskar Light or Carnsore Point, the southeasterly extremity of Ireland, about 70 miles from Queenstown. The only hope, therefore, of reaching the enemy was that something would happen to the engines of one of the latter's ships. The cruisers were, notwithstanding, given orders to pursue the enemy, and the whole fleet proceeded at its maximum speed. The result is interesting in view of the circumstances under which the ships made the run. The 13 battleships of the reserve fleet, of various types, and cruisers and destroyers of every class proceeded in a pretty heavy sea. The gunboats gave out entirely and received orders not to join in the chase. The torpedo boats, however, advanced valiantly. Cruiser *Galatea* had to be left behind, owing to lack of coal. She had but 140 tons in her bunkers the night before. The battleships made an unusually good run. At 10:40 a. m., when the *Alexandra* sighted the hostile battleships, their engines were making 42 revolutions; at 11:42, 54, and at noon they were under full power, the ships running 13 knots. By midnight the *Alexandra* had only 139 tons of coal left in her bunkers, and by noon of the following day she had less than 100 tons in her reserve bunkers, where it had been lying for seven years or more. With this old coal the *Alexandra* made 13 knots, as well as the rest of the fleet, until 2:45, when the chase was abandoned and the speed reduced. It was an excellent performance for this antiquated 10-knot squadron, and proved that the Admiralty did right in keeping and repairing these ships. At 3 o'clock p. m. the battleships of Fleet B proceeded to Milford Haven, leaving the 11 cruisers to continue the pursuit until 5 o'clock. It was thought that they might possibly come upon a disabled cruiser before the enemy reached Queenstown or after passing it. In any event the cruisers of Fleet B, though toward the end of the operations they had to replenish their bunkers and were in danger of torpedo-boat attacks, remained in touch with the enemy, so that they had some chance, after completing with coal, of meeting with the hostile fleet. Of course the cruisers might be driven off or eluded, and in that case Fleet B would be in the same position that it was three days earlier. If news of the utmost importance had been received, the situation of the fleet, as far as coal was concerned, was the same as that of the United States squadron in the West Indies while Admiral Cervera was at Curaçao. Shortly before midnight of August 2 Fleet B entered the harbor under some difficulty, owing to to the blinding rays of the search-lights of the forts. A request to turn the search-lights off was of no avail.

On August 3 Fleet B coaled at Milford Haven in stormy weather and the colliers sustained some injuries. One of them was driven off from the *Colossus*. Old hawse bags were used in coaling. Of the 13 colliers assigned to Fleet B for the time of the maneuvers, the largest carried 2,250 tons and the smallest 950; their average speed was from 9 to 10 knots. The rate per register ton at which they had been chartered varied between 13 and 15 shillings a month. There is now under consideration the construction of two colliers answering all the requirements deemed essential by experienced naval officers, one of the *Majestic* class and the other to correspond to modern cruisers of the *Ariadne* type. For cruisers, which nowadays consume such enormous quantities of coal, it is considered more necessary than ever to shorten the time required for coaling in port. The *Ariadne* consumed in twenty-four hours, from August 1 to 2, 235 tons, while the *St. George* during the same period used 117 tons, which shows that a modern first-class cruiser requires more than twice as much coal as a first-class cruiser built only ten years ago. Even the new second-class cruiser *Vindictive* consumes considerably more than the *St. George.*

Before leaving Milford Haven the fleet received the decision of the umpires relative to the appearance of the fast third-class cruisers *Prometheus* and *Perseus* off Campbeltown on July 31, at 11:40 a. m. The *Renard*, which had already been put out of action by the *Diadem*, was now pronounced to have been sunk by these two fast cruisers. The fleet left Milford Haven August 4, at 6 o'clock a. m. The target practice which was to be held in connection with the maneuvers was put off on account of the heavy sea. * * *

Fleet A assembled at Portland and left the harbor on the morning of July 16, with the exception of the *Gibraltar*, which had a bent piston rod and had to return to Portsmouth for repairs. She rejoined the fleet, however, before the beginning of hostilities. The *Majestic*, *Diadem*, *Blake*, and *Edgar* were equipped with apparatus for wireless telegraphy, constructed by Captain Jackson, differing but little from the Marconi system. Considerable difficulty was experienced in getting the apparatus to function properly. On July 18 the flagship received a message from the *Blake* over a distance of 21 miles. But on the whole wireless telegraphy did not prove reliable. The sending of more than one telegram simultaneously from different stations is fatal to its reliability. In the case of friendly ships, it is true, this can be obviated. But a hostile ship may interfere with the communication by remaining passive or by putting its own apparatus in operation.

The weather was on the whole bright, clear, and warm. Immediately after putting to sea, however, Admiral Rawson had a series of exercises with the different fog signals carried out, and soon the fleet struck a zone of drizzling fog. While under way the battleships were constantly performing evolutions, the cruisers were given exercises in scouting and safeguarding, and the crews on board all the ships were drilled in exercises of various kinds. But for newly mobilized ships the time available for these exercises was too short to attain perfection for the period of hostilities. Fleet A reached Berehaven in the afternoon of July 19, and found the torpedo-boat flotilla assigned to this port already engaged in exercises at the entrance to Bantry Bay. The forts of Bere Island had been placed in a state of defense, so as to enable them to take part in the defense of the roadstead in case it should be attacked. The only object of the visit at Berehaven was to give Admiral Rawson an opportunity to complete his preparations, instruct the officers who had been intrusted with special commands, and to confer with the military authorities. The assumption was that Squadron A2, whose base was Lough Swilly, would leave for that place the same night, but not to remain there, as the squadrons were not to arrive at their respective base ports before 6 o'clock a. m. of the 23d, the time set for the beginning of hostilities. Squadron A3, the reenforcement from the Mediterranean, would presumably leave July 20 for a rendezvous off Cape Finisterre, 44° north latitude and 15° west longitude, and remain there, outside of the maneuver field, with sealed orders for its future movements. The nature of these movements was to be announced to both parties, simultaneously, by telegram from the Admiralty to the effect that the reenforcement squadron had passed Gibraltar at a given time on a northerly course. Squadron A1 was to leave Berehaven on the 20th and proceed to Queenstown, returning thence to Berehaven before 6 o'clock a. m. of the 23d, at which time A2 was to be allowed to enter Lough Swilly, B1 Milford Haven, and B2 Lamlash. As soon as the Admiralty learned by telegraph that the four squadrons had reached their respective base ports war was to be declared and notice given of the hour for the beginning of hostilities by telegrams sent simultaneously to the four ports. The cruisers and torpedo boats were then to be at liberty to put to sea at once, but the battleships were first to coal.

It is not deemed necessary to go into details as to the evolutions and other preliminary exercises, which, while of the utmost importance as a preparation for maneuvers, are common to all navies. The composition of the two fleets was similar only in so far as they had been formed of ships having the same speed. Squadron B2, composed of the *Sanspareil*, *Nile*, *Trafalgar*, and *Benbow*, had the advantage of homogeneity. The Channel Squadron, forming the nucleus of Fleet A and considered to be the fastest and tactically most movable squadron in the world, had been intentionally hampered by the assignment to it of several slower ships, such as the *Sultan*, *Edinburgh*, *Dreadnought*, and others. Misgivings arose in British naval circles that a reenforcement of this kind might be contemplated also in case of actual war, and the great disadvantages of such a measure, which would disqualify the Channel Squadron, were pointed out. A demand was made for a permanent 50 per cent reenforcement by means of a homogeneous reserve fleet. This demand has recently been acceded to.

The cruising speed of the Channel Squadron in its usual formation is 14 knots, for maneuvering purposes 12, and more often 10 knots. Its maximum speed is 15 knots, which can be maintained constantly as long as the coal supply holds out. Owing to the assignment to it of slower ships, its maximum speed was reduced to 11 knots and its maneuvering speed to 8 knots, or 20 and 33⅓ per cent, respectively. Its tactical mobility also was reduced from 40 to 50 per cent, since the tactical diameter of the ships of the Channel Squadron was, by the combination with other ships, increased from 450 to 550 yards. This applies partly also to Fleet B. In view of the lack of homogeneity of both fleets, the preliminary tactical exercises were all the more important. There is a general fear prevailing in English naval circles that nowadays the tendency is to attach too much importance to the strength and efficiency of the matériel and neglect the more important factors of personal and moral efficiency or personal skill, intelligence, and experience, and tactical solidarity and cooperation; also, that the training in connection with cruisers, whose tasks are far more difficult than those of battleships, is inadequate; that they are placed in commission each year, though in large numbers, yet for too short a period, so as not to interrupt for too long a time the officers' courses of training ashore; also, that there is need of a general scouting system that has been put to the test and will be applicable under all circumstances.

The flagship of Squadron A1, the *Majestic*, left Berehaven alone on July 20 for Queenstown, where she arrived on the morning of the 21st. Prior to that time Squadron A3 had left for its rendezvous off Cape Finisterre, and on the evening of the 20th A2 had proceeded to Lough Swilly. The other ships of A1, *Repulse*, *Dreadnought*, and *Sultan*, put to sea on the 22d and rejoined the flagship at 6 o'clock a. m. of the 23d. Fleet A also had fog and dark weather to contend with. A characteristic feature of this year's maneuvers was that the fortified ports had been placed in a state of defense, as far as their conditions permitted. A had three of these ports: Queenstown, Berehaven, and Lough Swilly; B had only one, Milford Haven, as Lamlash had no works of defense unless they were improvised. The object of Admiral Rawson's visit at Queenstown, the same as at Berehaven, was to confer with the military authorities and to inspect in person the condition and preparedness of the coast defenses. Those at Queenstown are more modern in construction and equipment than at Berehaven. The war office had had little time for the preparation of the coast defense, but the local military authorities had lent efficient assistance.

The circumstance that at the time of the declaration of war both fleets were divided had to be taken into consideration. A was partly at Berehaven, partly at Lough Swilly, and partly on the high seas, while B was partly at Milford Haven and partly at Lamlash. The first question, therefore, was concentration of their forces. Another feature was that colliers after the breaking out of hostilities were open to capture. A had all of its colliers in fortified ports, which circumstance, while not precluding an attack upon them, rendered their capture much more difficult. B, having colliers in the open port at Lamlash, had the choice of using Milford only as a coaling base, or of having the Lamlash colliers proceed to Milford at the risk of being captured, or, finally, of stationing colliers at Lamlash and other open places in its own or in hostile territory, running the risk of being captured in case they could not be protected by warships. In the case of Fleet A also the necessity might arise of stationing and protecting colliers at different places, so that the question of coaling and the protection thereof might be of considerable influence on the beginning of hostilities and on the operations generally. A third feature was that no special regulations restricted the admirals in their actions as long as they were in accordance with the usages of war.

On July 23, at 6 o'clock a. m., the *Majestic* and the remaining battleships of A1 arrived once more at Berehaven and immediately commenced coaling, which was completed in the afternoon. The order for the beginning of hostilities arrived shortly before midnight, fixing the duration of the same from 2 o'clock a. m. of July 24 to 2 o'clock a. m. of August 3. The situation as far as A was concerned was as follows: As stated, Squadron A1 was at Berehaven, with battleships *Majestic*, *Dreadnought*, *Repulse*, and *Sultan*, cruisers *Sirius*, *Perseus*, *Diadem*, *Edgar*, *Gibraltar*, *Immortalité*, *Talbot*, and *Naiad*, and a number of torpedo boats and torpedo gunboats, the remainder of which had been sent to Queenstown. A2 was at Lough Swilly, with battleships *Prince George*, *Resolution*, *Edinburgh*, and *Conqueror*, cruisers *Retribution*, *Apollo*, and *Phoebe*, and the torpedo-boat flotilla. Squadron A3—that is, battleships *Magnificent*, *Jupiter*, *Hannibal*, and *Mars*, and second-class cruisers *Gladiator* and *Furious*—was on its way to a rendezvous 200 miles east of Cape Finisterre, with sealed orders containing the time when the squadron was to make its appearance to reenforce Fleet A. Until its arrival Admiral Rawson, therefore, had only 8 battleships to the enemy's 13. Consequently he had to proceed in such a manner as not to be closed in and blockaded in his base ports by the superior enemy. The question then arose as to what the enemy was likely to do. For both parties, as already stated, concentration of their forces appeared to be the first problem; but Admiral Rawson seemed to think that Admiral Noel would attempt first to hold the northern and southern entrances to the Irish Channel with the forces stationed in their vicinity, thus protecting the central part of his own territory, and would then base his subsequent measures upon those of the enemy. On this assumption, which was perhaps daring, and was soon to be controverted by the events, Admiral Rawson based his first dispositions. As he had only 8 battleships at his disposal, he could not hope to force the southern entrance to the Channel, which he supposed to be held by the whole Squadron B1; but by uniting his two squadrons, or with A1 and part of A2, he would be able to force the northern entrance to the Irish Channel and destroy the unfortified hostile base of Lamlash before Fleet B would be able to reach there to defend it. A1 therefore left Berehaven, accompanied by cruisers *Sirius*, *Blake*, and *Perseus*, and the torpedo gunboat *Skipjack*, at 2 o'clock

a. m. of July 24, on a northerly course. At the same time the *Prince George* and *Resolution*, with cruisers *Retribution*, *Apollo*, *Phoebe*, and *Prometheus*, proceeded from Lough Swilly to a rendezvous with A1 off Blacksod Bay. Battleships *Edinburgh* and *Conqueror* of A2 remained, for the time being, at Lough Swilly, because they had less speed than the others and a very small coal supply. On the evening of the 24th both squadrons arrived at Blacksod Bay. The arrival of the northern squadron was reported by the *Blake* by means of wireless telegraphy over a distance of 15 miles. The *Blake* did not have the regulation apparatus, but one that had been borrowed of the torpedo training ship at Devonport; but the working of the apparatus was by no means reliable; while messages were successfully sent over distances of more than 20 miles, it was only with great difficulty that telegrams were received from short distances.

Admiral Rawson, on the evening of the 24th, had at his disposal a sufficiently strong battle fleet to force the northern entrance to the Irish Channel, but he left two battleships at Lough Swilly exposed to blockade and torpedo-boat attacks, though at great risk to the attacking party. So far Squadron A1 had been without information as to the adversary. But now a cruiser dispatched to Blacksod Bay reported that she had sighted in the afternoon 4 battleships, apparently Squadron B2, about 15 miles from Malin Head, steaming in a northwesterly direction. There seemed to be no reason why the enemy should show their battleships at this point if they wished to remain unobserved, and A was therefore of opinion that no certain conclusion could be drawn from their course, except that they would be sure to change it as soon as they were out of sight of land. Of these battleships Fleet A saw and heard nothing further directly. But on the morning of the 25th, while the battleships were still steaming to the northward, the hostile cruiser *Minerva* was sighted following them. As soon as she had come near enough for observation, she changed her course to the southwest and later to the south. While she was still in sight, Fleet A changed its course to the westward, and upon perceiving smoke in a northwesterly direction, dispatched the *Blake*, *Apollo*, and *Retribution* in that direction. The smoke proved to be that of the two hostile cruisers *Blenheim* and *Melampus*, which were steaming in a northeasterly direction, but when they found they were pursued changed their course to the southwest. The *Blake* fired upon the *Blenheim* at long range and claimed, though unsuccessfully, to have put her out of action. When Fleet A sighted this cruiser it changed its course once more to the north and dispatched the *Sirius* to Blacksod Bay for reconnoissance and with instructions to the *Blake* and her companions to return to the fleet as soon as they had driven off the hostile cruisers. When the *Blake* returned alone and reported that she had left the *Sirius* and *Retribution* behind as an escort, in view of the two hostile cruisers, of which only the *Blenheim* was a first-class cruiser, she received orders to go back and reenforce this escort. Fleet A then stopped her engines for several hours in order not to arrive at a rendezvous designated at Lough Swilly before the *Sirius* and the other vessels. The *Blake* then reported by wireless telegraphy over a distance of 20 miles "important news." The *Diadem* reported from Queenstown that early in the morning the whole Squadron B1 had been at Brow Head, though out of sight of land, steaming on a northerly course. When A1 left Berehaven, the *Diadem*, together with cruisers *Edgar*, *Gibraltar*, *Immortalité*, *Talbot*, and *Naiad*, had remained behind with orders to observe the enemy's movements off the southern coast of Ireland, and in case the southern entrance to the Irish Channel should be left unprotected, to steam at once for those waters, but to wait for further orders at Queenstown. In conformity with these instructions, the *Diadem* squadron had watched the movements of the hostile squadron off the southern coast of Ireland early in the morning and was evidently engaged with it, which did not prevent it, however, from observing the enemy at Brow Head, an important signal station near Cape Clear.

The *Sirius* now brought the telegram from the Admiralty that A3 had passed Gibraltar on the morning of the 25th, at 10 knots speed and on a northerly course. This squadron had to pass a rendezvous 40° north latitude and 14° west longitude, and it would therefore be seventy-two hours before it could reach the southern boundary of the maneuver field and carry out Admiral Rawson's orders to steam along the fifteenth meridian to a point 53° 30′ north latitude and then shape its course straight for Lough Swilly.

This highly important information changed Admiral Rawson's plans immediately and completely. The three cruisers sighted in the morning had all gone southward upon being pursued. It was known that they had been assigned to Squadron B2, and their movements seemed to indicate that this squadron had also passed the A fleet on its way to the south. If so, it must have been at night, and it was unfortunate for Fleet A to have missed it, for it had now become impossible to intercept it in time to prevent its junction with B1 at Brow Head or vicinity. In any event the indications, though daring, in view of the fact that B1 had been at Brow Head in the morning, seemed to be that it was Admiral Noel's intention to concentrate his whole fleet in the vicinity of Brow Head for the purpose of intercepting A's reenforcements from the south. This he could do by steaming to the southern boundary of the maneuver field to a point north of the rendezvous of A3 and there occupying a line of sufficient extent to make it almost certain that the hostile fleet could be intercepted. Or he could take up a central position on a line from Brow Head to the western boundary of the maneuver field in 20° west longitude, in hopes either of intercepting A3 or of preventing a junction of A1 and A2 with A3. In either event he would have occupied a position of sufficient advantage to paralyze Admiral Rawson's originally intended offensive with A1 and A2, A3 being cut off and in a dangerous position. In view of this situation, the intended advance of the *Diadem* squadron into the Irish Channel was at once abandoned, because, while it might still be feasible, it would not promote the main object of the operations—the command of the sea—and might even place that object beyond the attainment of the A fleet, if the destroyers of the B fleet, which must be supposed to be cruising in the Irish Channel, succeeded in torpedoing some of A's battleships. Admiral Rawson, having arrived at the conclusion that Admiral Noel was determined to meet with A3, decided to do his best to frustrate such intention. The first thing to be done was to get the two battleships from Lough Swilly. The *Majestic* was sent after them and to forward dispatches to the coast, arriving at Lough Swilly at 5 o'clock a. m., when both of the ships were already getting up steam. Admiral Rawson's conception of the situation and the contents of the dispatches received may be conjectured from the following signal made by the Admiral to his fleet: "I assume that B1 and B2 are by this time united and at a short distance from Brow Head. I intend to effect a junction with A3, which will probably lead to an engagement. The cruiser division *Diadem* is instructed to proceed to a point 47° 35′ north latitude and 15° west longitude, thence following the fifteenth meridian, so as to meet with A3. A3 leaves the Admiralty rendezvous, a point 44° north latitude and 14° west longitude, at midnight Friday, and will proceed along the fifteenth meridian at a speed of 12 knots."

On the morning of the 26th the situation, after Admiral Rawson had issued his instructions, was as follows: A1 and A2 were together in full force off Lough Swilly. Their position and probable movements had been observed by several cruisers and destroyers of the B fleet and had probably been reported to Admiral Noel at once. Admiral Noel, with B1 and B2, was assumed to be in a position at some distance from Brow Head, whence he could proceed with all his forces in order to intercept A3 upon entering the maneuver field, or where he could remain and have his ships form a large semicircle with Brow Head for its center and a radius from there to the twentieth meridian. If B with all its forces left for the southern boundary of the maneuver field, shaping its course for a point near the rendezvous of the Admiralty, it was almost certain to intercept A3 before A1 and A2 could appear on the scene, and although B, in view of the superior speed of A3, would not be able to force the latter to a decisive action it would certainly be in a position to drive A3 sufficiently far from its intended course to cut off communication with A1 and A2. If, on the other hand, B preferred to hold a line from Brow Head westward, A would not be able to effect a junction of its forces without the knowledge and probably the interference of B, unless one or the other, or both, could get through beyond the arc whose radius was the extreme distance which B could protect to the westward of Brow Head. But A3, as stated, was proceeding northward on the fifteenth meridian, which course was not far from the center of the position taken up by B, and could, therefore, not be followed without great danger. New orders were therefore necessary for A. These were issued in the shape already indicated in Admiral Rawson's signal. The same signal explained the course taken by Admiral Rawson himself. He was endeavoring to establish touch with A3 by steaming outside of B's presumed field of observation to a rendezvous 47° 30′ north latitude and 20° west longitude, where, if all went well, he could hope to effect a junction with the *Diadem* and Squadron A3 on the afternoon of Sunday the 29th.

Such was the situation as it presented itself to Admiral Rawson on the morning of the 26th, and he shaped his operations accordingly. But the situation offered many uncertainties relative to the concentration of B and its advance upon A3, as also concerning the execution of the orders to the *Diadem* and *Blake*, who had been instructed to warn A3 as to the fifteenth meridian and assign a new rendezvous on the twentieth meridian. During the night of July 26, when the *Majestic* was between 100 and 200 miles west of Lough Swilly, 55° north latitude and 18° west longitude, the receiver of its wireless telegraph apparatus manifested an agitation from which it was safe to conclude that a ship sending messages was within the radius of imperfect influence upon the apparatus, but not within that of perfect transmission—that is to say, at a distance of about 30 miles. This agitation might be the result of atmospheric, cosmic, or electric disturbances in the ship. But if they were the result of telegraphing on board of ships in the vicinity the latter could not belong to the A fleet. The *Diadem* and *Edgar* were hundreds of miles away. The *Blake*, which had been detached, was not to use its apparatus, by orders of the admiral, as long as a hostile cruiser was near. The agitation might therefore proceed from a hostile cruiser equipped with wireless apparatus, which in its turn was within signaling distance of another cruiser also having wireless apparatus on board. It was hardly to be assumed that these ships were steaming singly, but rather that they were operating in conjunction with other hostile cruisers and with their flagship. From this assumption it followed that, if not the whole B fleet was north of A on the night of the 27th, such must certainly be the case as to some of its cruisers, and judging by their presence there the length of the line of observation which Admiral Noel might establish at some other point was considerably shortened.

During the afternoon of the 29th Fleet A passed on its southward course, the critical point where it was most likely to meet with the hostile cruisers. But nothing of the kind happened. After passing it the *Conqueror*, which experienced difficulty in maintaining the speed of the fleet (10 knots) and was short of coal, was detached with instructions to proceed at slow speed to a point where the fleet would rejoin her on July 30 after its return from the rendezvous with A3. Early in the afternoon the *Apollo* was dispatched to look out for Squadron A3, with orders, in case she should meet it, to instruct it to join A north of the rendezvous. These were the only incidents of the 29th. Fleet A, not being sufficiently strong, had avoided a front attack upon the adversary and was in hopes, by a wide flanking movement, to pass around their position and receive sufficient reenforcements to resume the offensive. The flanking movement had succeeded, and if the reenforcements had not lost their way and had not been intercepted Fleet A, during the last four days of the maneuvers, would have as many battleships as in the beginning, and having all its forces together would be in a position to offer battle to the enemy, under as favorable circumstances as the conditions permitted, in order to gain the command of the sea. But all depended on the junction with A3. Had the enemy intercepted it as it entered the maneuver field? Had the *Diadem* received its orders early enough to carry them out? Had the *Blake* and *Conqueror* passed safely through the hostile cruisers? Would the *Apollo*, upon reaching the rendezvous, find A3 there? All these questions were pending, and if answered unfavorably the maneuvers would be sure to end in the defeat of Fleet A. The A fleet had undertaken the carrying out of a great combination. Admiral Noel, with the B fleet, seemed to want to prove that the best defense of the Irish Channel against attacks from a fleet was not to protect it by strong forces, but to get all his fighting forces in a position from where he could frustrate the enemy's plans.

When Admiral Rawson learned of the enemy's movements, he did not proceed to any attack upon the defenseless coast of England, but at once advanced upon the Irish Channel, where he had so far supposed the enemy to be and where he had hoped with his superior forces to meet one of the hostile squadrons, and decided to concentrate all his forces at a position chosen by him and do his best to gain the command of the sea. But his game was not a strong one, nor was it easy. He himself was at Lough Swilly, his reenforcements a few hours from Gibraltar, and he assumed that the enemy had taken up between them the most favorable position in the whole maneuver field. The measures which the admiral took for uniting his widely separated contingents have already been referred to.

After the *Conqueror* had left Fleet A on the morning of the 28th, nothing of importance happened until the afternoon of the 29th, with the exception of the temporary disablement of the steering gear of the *Edinburgh* and the mysterious agitation of the wireless telegraph apparatus from 11 o'clock p. m. until 3 o'clock a. m. As it could not be traced to any telegraphing from the three far-distant cruisers, there remained only the explanation of electric disturbances in the atmosphere. Up to that time the weather had been fine, clear, and unusually warm, with little wind, rare showers, and without any fog. But on the 29th heavy fog banks interfered at times with keeping a lookout for Squadron A3. The A fleet could expect to sight A3, if at all, about 2 o'clock in the afternoon, and just about that time it really hove into sight, coming from the east and shaping its course for the same rendezvous for which Fleet A was bound. Soon after the *Blake* arrived, but the *Diadem* and her division of cruisers were not with her, nor had they been seen. They were not at Queenstown when the admiral's telegram had arrived there on the morning of the 26th, and while the *Seagull* was dispatched to look for them the *Pioneer* was sent to transmit the admiral's orders to the rear-admiral in command of Squadron A3. All the measures of A had thus been correct, and an order for a change in the strategic dispositions, which had arrived on the morning of the 26th from Lough Swilly, had been carried out punctually on the afternoon of the 29th at a point 15 miles north of the new rendezvous, in 47° 35′ north latitude and 20° west longitude, which the *Pioneer* had indicated to the admiral. Great relief was felt on board the flagship when A3 hove in sight. While A had not won the game, it was holding the best cards that could fall to its share in view of the Admiralty's dispositions. Admiral Noel, it is true, was still the stronger; but much depended now on the way the game was played. What had become of the *Diadem* squadron was not known, but capture was hardly to be feared for these very fast vessels, and it was thought possible that they would rejoin the fleet before the decisive battle, which A calculated would take place not later than the afternoon of August 1.

Admiral Rawson, with his whole fleet, shaped his course northeasterly for a rendezvous where he hoped to meet the *Conqueror* in the course of the day. The latter rejoined the fleet during the forenoon, whereupon the admiral started for a rendezvous south of Queenstown, which, if all went well, he expected to reach in the afternoon of the 31st. Simultaneously the *Gladiator* and *Furious* were dispatched to Berehaven with orders designed to concentrate at or near Queenstown in time for the final battle all the available forces of Fleet A, namely, 12 battleships and as many cruisers, torpedo boats, and torpedo gunboats as had not in the meantime been set out of action by the enemy. But even if all the battleships of the A fleet were present at the final battle, the B fleet, with its 13 battleships, provided they were all there, was still at an advantage, though not sufficient to preclude the possibility of a victory on the part of A.

In the afternoon of July 31 Fleet A, upon approaching Queenstown, sighted two hostile cruisers, apparently the *Blenheim* and *Cambrian*, steaming in an easterly direction, pursued by the *Blake*, but their fire upon the latter was at too long range to permit them to claim having put her out of action. Soon after the *Diadem* hailed the *Blake* by wireless telegraphy. This was the first that had been seen or heard of the *Diadem* and of the movements of the enemy since July 25. The reports of the *Diadem* as to the hostile fleet proceeded from the Brow Head signal station and were identical with those made by the *Furious*, which latter, together with the *Gladiator*, rejoined Fleet A on the afternoon of the 31st. While the fleet was on its way to the rendezvous, these two ships had joined the *Diadem* division, which was complete with the exception of the *Gibraltar*, which in an engagement of this division with a hostile cruiser division had been temporarily put out of action, while the enemy had lost the *Hawke*. The hostile battleship fleet, with four cruisers, had been sighted by both reporting vessels on the morning of July 31 at Orlok Point, south of Belfast Lough, steaming in a northeasterly direction, apparently bound for Clyde. This seemed to indicate either that Admiral Noel was expecting Fleet A from the entrance to the Irish Channel or that he felt uncertain as to the direction from which to expect it and was therefore cruising in a position from which he could advance in either direction. Evidently he had stationed a strong contingent off the southern coast of Ireland, and it was with these forces that the *Diadem* had had an engagement. The hostile cruisers referred to were the *St. George*, *Ariadne*, *Hawke*, and *Vindictive*, supported by four destroyers, against the *Diadem*, *Gibraltar*, *Edgar*, *Immortalité*, and *Naiad*, of Fleet A. So far no advantage had been gained on either side, nor had the equilibrium been materially disturbed by an engagement off the Skelligs between the *Minerva* (B) and three torpedo boats of the A fleet from Lough Swilly, the result of which was that both parties were put out of action. The enemy, as the result of various engagements, had also lost torpedo gunboats *Leda* and *Alarm* and destroyers *Thrasher*, *Wolf*, *Spiteful*, and *Cheerful*, which had been ordered to proceed into port. Finally, Fleet A had lost the *Lesvaulx*, one of the two distilling ships which had for the first time been assigned to both parties for maneuvers. The employment of such auxiliaries for the navy is looked upon with favor in British naval circles, but higher efficiency is demanded than possessed by these particular vessels. The *Lesvaulx* has a water capacity of 853 tons, but can distill not over 27 tons a day and pump not over 10 tons an hour. She is also very slow, which circumstance was partly the cause of her capture. This was not much of a loss for the A fleet, and the fact that the distilling ship was sent to Lough Swilly led Admiral Noel to the assumption that Admiral Rawson was making this port his principal base. The *Furious* further reported: "We arrived at Berehaven at 4 o'clock a. m., in dark weather, unperceived by the land forces. We entered the harbor, and upon anchoring were fired upon by the coast guns." This did not speak well for the land forces, but the principal blame is attached to the coast-guard station. Berehaven, as stated, had been placed in a state of defense. This was also the case as to Lough Swilly, but when Admiral Rawson wanted to enter this harbor not very early in the morning of the 26th he had to wait three-quarters of an hour before the military authorities were sufficiently awake to grant him permission to enter without being fired upon.

On the morning of August 1, when Fleet A arrived in Queenstown, it was informed by a signal from Roches Point of the result of the cruiser engagement on the 25th, which, as previously stated, put the *Gibraltar* (A) and the *Hawke* (B) temporarily out of action, and also of the fact that the *Naiad* had been sunk by a torpedo boat. In addition, the *Seagull* on her way to the A fleet, with reports from a rendezvous south of Queenstown, had been captured by the enemy on July 31.

On the morning of August 1, Fleet A with all the forces it had left, except only the torpedo-boat flotilla stationed at Lough Swilly, proceeded along the southern coast of Ireland with course shaped for the entrance to the Irish Channel. The torpedo-boat flotilla stationed at Berehaven and Queenstown joined the fleet that same morning, but as a strong wind came up from the southwest and there was considerable sea, it was sent for the night to Waterford with instructions to return to the fleet the next morning, the weather permitting. Fleet A went no farther than the entrance to the Irish Channel, when it turned about, steaming slowly westward, and sent its cruisers out for reconnoissance from the signal station of Carnsore Point, at the southeastern extremity of Ireland. The *Sirius* returned with the news that the B fleet, shortly after 9 o'clock that morning, had still been in the vicinity of Belfast, so that it was not possible for the two fleets to meet before the morning of August 2. Admiral Rawson intended to turn east again during the night, in order to arrive in the morning at the entrance to the Irish Channel, and await there the issue of the maneuvres on August 2. The *Edinburgh* and *Conqueror*, which were short of coal, were left over night at a rendezvous to the eastward, where they were again to be called for by the fleet in the morning. A strong wind came up and the sea was rough. Farther north also the weather was unfavorable, so that A's torpedo-boat flotilla had to be left at Lough Swilly. This might affect Admiral Noel's movements in so far as it delayed the moment when Fleet A could expect to meet him.

At 9 o'clock a. m. of August 2 the cruisers and torpedo gunboats of Fleet A assembled at Waterford and chose a course designed to bring them to Milford Haven before the day was over.

At 10 o'clock a. m. Fleets A and B for the first time during the maneuvers came into contact about 20 miles off Waterford. B was complete as to battleships. A was minus the *Conqueror* and *Edinburgh*, which, unable to steam against the heavy sea, had been dispatched to Queenstown the day before. A was therefore not in a position to accept battle and was compelled to withdraw. During its retreat the *Dreadnought* was likewise sent to Queenstown, as she was not able to maintain the speed of Fleet A. Finally, the *Sultan* also, which lagged behind, was sent to Berehaven, while the remainder of the battleships continued the retreat at a speed of 14 knots. By 2 o'clock p. m. Fleet B gave up the chase, but some of its cruisers kept the A fleet in sight for two hours longer.

Owing to the heavy sea and dark weather, the destroyers of Fleet B did not make any attack upon A during the night.

When the maneuvers terminated, at 2 o'clock in the morning of August 3, the result had to be considered undecided, as Fleet B had not succeeded in winning the command of the sea, although it had gained a temporary advantage on August 2. Fleet A kept all its battleships, and as a battle fleet it was as intact as at the beginning of the maneuvers.

The wind and sea had calmed down, but were still too strong for the torpedo boats. In view of the scant coal supplies of the *Edinburgh* and *Conqueror* and the tactical inefficiency of the latter in such weather, Admiral Rawson had sent these two ships to Queenstown, where the A fleet rejoined them on the morning of August 2. This fleet was therefore likely to come upon the enemy with only ten battleships. It is true that Fleet B also might meet with difficulties which would impair its strength in a similar manner. The Admiralty had classed all the battleships as belonging to the *Magnificent* class, but this fiction broke down, even under the requirements of a ten-days' maneuver.

At last the enemy's cruiser squadron, and soon after their 13 battleships, hove in sight. To fight them with only 10 battleships was out of the question, unless Admiral Rawson was willing to throw up the game and leave the enemy at the conclusion of the maneuvers to a certain extent, if not entirely, in command of the sea. He would have had some chance of fighting the 13 battleships if his two absent battleships had rejoined him with full bunkers; but as long as he was not compelled to fight with his reduced forces his fleet remained a disturbing factor for the enemy's command of the sea. The admiral therefore decided to turn back in a southwesterly direction, in order to have the wind and sea in his favor and place the enemy's slow ships at a disadvantage as to speed. By 2 o'clock p. m. he increased his speed to 13½ knots, in order to render it more difficult for the enemy—who could not run over 12 knots, though some of their ships made 14 knots—to come up with him. This advantage of increased speed had been rendered possible only by the prompt dispatching of the *Dreadnought* to Queenstown. The only lay figure now left in Fleet A was the *Sultan*, though rather from the standpoint of fighting efficiency than that of speed. The torpedo gunboats also were promptly sent to Waterford, where they might have a chance, if the hostile ships should pursue the retreat, of putting them out of action before the end of the hostilities. Fleet A had no fear that the enemy would overtake it before the expiration of that period, but if it did not succeed in shaking them off before dark their torpedo boats would have a chance of attack during the night, though the weather and the sea lessened this chance considerably; but the fleet had to increase its speed to 14 knots, and therefore sent the *Sultan*, which could make only 13 knots, also to Berehaven, where she was to keep a sharp lookout for torpedo-boat destroyers. Soon after the hostile battleships gave up the pursuit and returned to Milford, but 6 cruisers kept the A fleet in sight until 5 o'clock p. m. When 4 hostile destroyers were sighted on a northerly course the *Blake* was sent out to chase them. Fleet A evidently had nothing further to fear between nightfall and 2 o'clock a. m. except attacks from torpedo boats, but although the wind had gone down the sea was still heavy, so that it was difficult for the destroyers to follow Fleet A and not easy to find it.

Such was the situation a few hours before the conclusion of hostilities. Fleet A, it is true, had not gained the command of the sea and was retreating as fast as possible in order to obviate defeat. But it still existed as a fleet, and if the maneuvers had lasted a few days longer it might have been able to resume the offensive. The enemy unquestionably retained their original superiority as to number, and while not gaining the command of the sea, had offered battle under circumstances which compelled Fleet A to refuse it. A's torpedo boats had undertaken no operations against the hostile battleships, which they might have been expected to do under the circumstances. The enemy had destroyers; A had none. The lesson to be derived from this is obvious. A party contending for the command of the sea with 12 battleships and two dozen torpedo boats against an enemy who has 13 battleships and two dozen destroyers may consider itself in luck if at the expiration of ten days its fleet still commands respect.

The result of the naval maneuvers, as stated, was not decisive, and it is not surprising that the struggle of the two fleets for the command of the sea was not carried to a decisive issue in the short period of ten days. Regret is therefore expressed in British naval circles that a definite time limit was set for operations whose course and development could not be foreseen. It is true that there are certain points as to which maneuvers will never be able to represent actual war conditions. They will always be bound to contain an element of agreement and assumption. But this element should be restricted to a minimum and as few rules should be laid down as possible in order to make the maneuvers as far as practicable similar to the reality.

It is on this basis that the plan of operations had been drawn up by the British Admiralty, and the umpires were instructed to decide each case on its merits on the basis of what would be probable in war. But this praiseworthy principle was violated in many respects, first of all in the disposition that the operations were unconditionally to terminate on a certain day at a certain hour. If an admiral knows that, whatever may happen, he will not have to fight beyond a certain moment, he will do many things that he would not think of doing, and positively could not do, if he had to fight for an indefinite length of time. Competent British naval authorities are of opinion that this factor, which is contrary to probabilities in war, should be eliminated by leaving the duration of the operations undefined. In some respects this might prove inconvenient and cause a great expenditure of coal. But when efficient service and thorough training are the points in question, convenience and economy are matters of minor importance. Better no maneuvers at all, it is argued in England, than a preponderance of these two factors, and it is believed that the maneuvers could be rendered much better and more instructive if these two questions were duly subordinated to other and far more important considerations. A struggle confined to a definite space of time can hardly be a decisive test as to endurance and the conduct of operations.

For this reason the lessons resulting from the maneuvers are more of a negative than of a positive character. Perhaps they are no less instructive for that reason, but they are not entirely reliable.

Another lesson of the utmost importance has resulted from the absurdity of trying, on the spur of the moment, to reenforce a fighting fleet simply by increasing the number of its ships, without regard to the quality and tactical mobility of the ships forming such reenforcement. The Channel Squadron in its normal formation consists of 8 homogeneous ships, which by long and careful training on the sea have been raised to a high standard of tactical efficiency. To this squadron were assigned for the period of the maneuvers 4 very inferior ships, not homogeneous among themselves and utterly heterogeneous in relation to the Channel Squadron. In the solution of almost every problem they constituted a factor of weakness for Admiral Rawson's fleet. They destroyed its tactical mobility and considerably hampered its freedom of action. If Admiral Rawson had had only the 8 ships of the *Majestic* class, he could not have been defeated by Admiral Noel, who commanded 13 less homogeneous ships of inferior speed, inferior tactical mobility, and inferior coal capacity; nor could he have been compelled to accept a battle which he himself did not desire. All these advantages were neutralized by the reenforcement.

According to a prominent British authority the following are the principal lessons taught by the maneuvers:

(1) The uselessness of placing old vessels in the first line with modern ones until the latter have been reduced by action to the level of efficiency of the former.

(2) The futility of expecting any decisive results when two fleets are engaged with no well-marked superiority on either side.

(3) The necessity of increasing tbe number of English scouting vessels, and affording greater opportunities for acquiring the art of efficient scouting.

(4) The importance of making arrangements for the proper cooperation of naval and military forces in time of war.

(5) The immense amount of coal which will probably be required during the preliminary maneuvering before any decisive action takes place.

(6) The necessity of making efficient arrangements in peace time for a proper provision of auxiliary vessels for the supply of coal, water, ammunition, etc.

CASUALTIES.

The *Trafalgar* collided with the passenger steamer *King Orry*. The damage done was slight.

The *Gibraltar* bent a piston rod and had to go to Portsmouth for repairs, from where she later rejoined the fleet.

The *Benbow* collided with a collier from which she was coaling at Milford Haven and smashed a boat and other fittings, necessitating several weeks' repairs.

The *Edinburgh* carried away her fore-topmast while steaming into a head sea.

The steering gear of the *Collingwood*, *Rodney*, *Hero*, and *Thunderer* broke down, but was repaired immediately.

Owing to an accident to the machinery of the *Pioneer* she had to be towed into Queenstown.

The *Sharpshooter* had to return to Plymouth for repairs on account of defects in her machinery.

The destroyer *Shark* failed so badly in speed and handiness that she was replaced by the *Opossum*.

Torpedo boat No. *45* on leaving Portsmouth collided with one of her consorts and was so badly damaged that she had to return to the harbor. Her bow was stove in and the forward compartment filled with water. Her place was taken by No. *51*.

Defects were discovered in the propeller shafting of torpedo boat No. *63* and she had to return to Plymouth.

Torpedo boat No. *76* struck some wreckage off Queenstown and knocked off one of her propeller blades.

Torpedo boat No. *77* had her propeller shafting damaged.

A sailor fell overboard from the *St. George* near Cardigan Bay and was drowned.

A chief stoker from the *Galatea* fell over a cliff at Torbay and was killed.

A seaman of the *Hero* fell from the top while cleaning a gun and was killed.

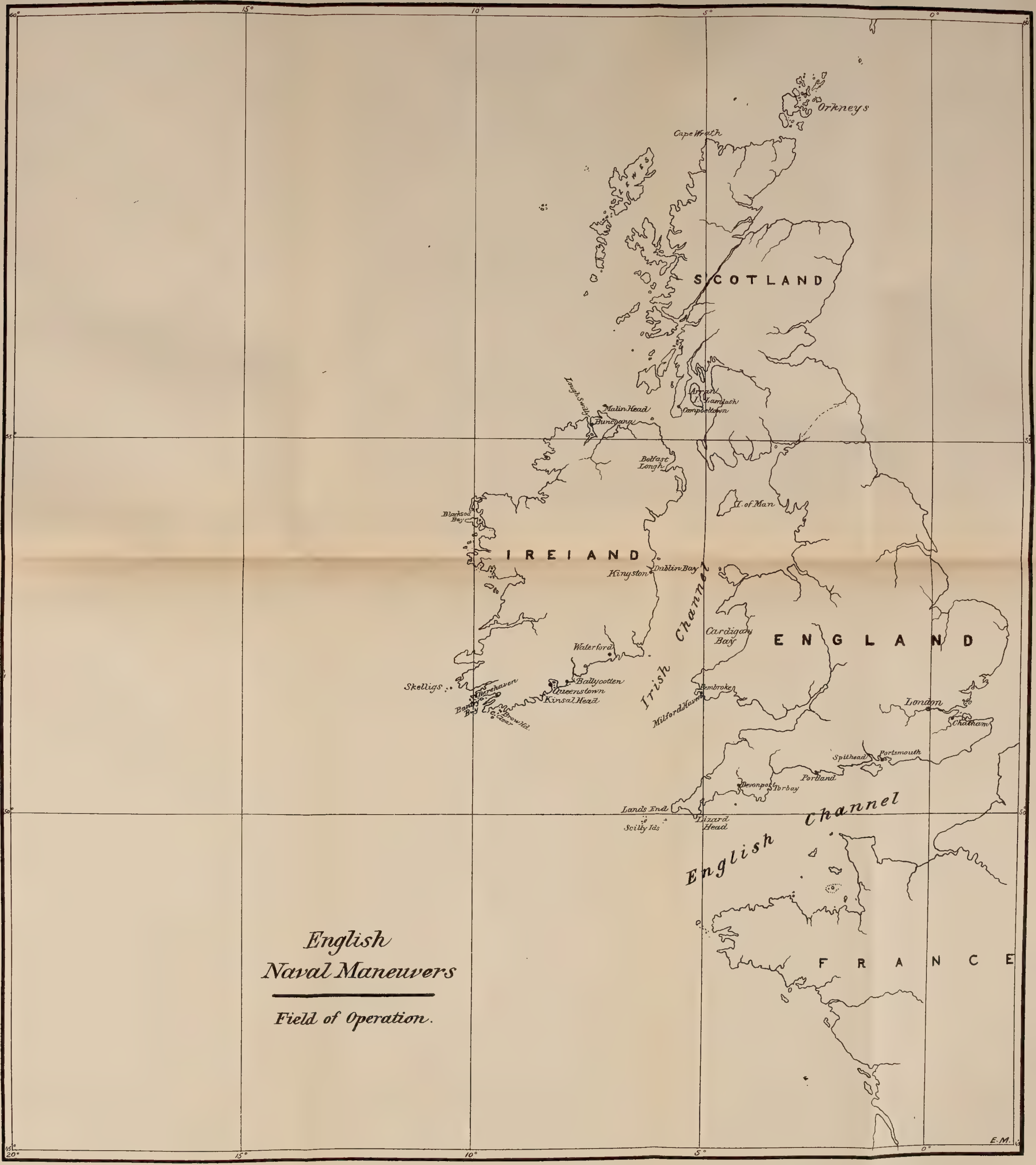
The *Benbow* lost four men. One fell overboard, another was killed by a derrick falling on him, a third fell over a cliff while ashore, and the fourth was killed by a coaling sack falling on him.

A leading seaman from the *Hawke* died.

On the *Camperdown* a block fell from aloft and inflicted a serious scalp wound on a gunner.

On the *Minerva* some ground tackle carried away while she was anchoring in Torbay and broke the legs of two men.

One of the crew of the *Rainbow* met with a serious accident.



English
Naval Maneuvers

Field of Operation.

SECTION II.

JAPAN.

The Japanese naval mobilization and maneuvers during the spring of 1900 were by far the most comprehensive of any maneuvers undertaken by that country. Practically the entire navy, matériel and personnel, participated, and in general the results were claimed to be satisfactory.

The maneuvers were executed with the greatest secrecy, no merchant ships being allowed near the maneuver grounds, and none of the foreign men-of-war in the vicinity were invited or given permission to attend. A strict censorship was placed on the press, and in consequence the following account must be more or less meager and possibly, in some instances, inaccurate.

The chief object of the maneuvers seems to have been to exercise and test a general scheme for the mobilization of the entire fleet and for the naval defense of Japan. Viewed from this point much valuable information must have been obtained. No new tactical or strategical problems were tried, and all movements were attended with so much secrecy that little in that line can be learned from the maneuvers by the "outsider."

POSITION OF MINES AND OBSTRUCTIONS.

Previous to the maneuvers the approaches to the principal ports were mined. The extent of these mine fields is shown by the following order, which was published by the Navy Department March 19, 1900, ten days prior to the beginning of the maneuvers:

NOTIFICATION NO. 5, DEPARTMENT OF THE NAVY.

In connection with the coming grand maneuvers explosives shall be sunk in the following places, and any vessels shall be forbidden to pass, anchor in, or fish in the places mentioned in from No. I to No. VII during eighteen days from March 29 to April 15, and in other places during twenty-nine days, from March 29 to April 26, except the place mentioned in No. VII, where passage of vessels shall be allowed.

No. I. The entrance of Tokyo Bay:

The sea surface within 1,200 yards of Cape Hatayama on the line connecting the said cape with the Third Sea Fortress.

No. II. The entrance of Yokosuka Harbor:

1. The line on which the northern extremity of Natsu Island is seen to N. W. by W. ½ W.
2. The line on which the northern extremity of Natsu Island is seen to N. W.
3. The line on which the northwestern extremity of Hoha Island is seen to S. W.

   The sea surface inclosed by the foregoing three lines, and at each intersecting point of the third line with the first and second, a buoy shall be placed.

No. III. The entrance of Omura Bay, Higo Province:

1. The lines that connect the following buoys, successively:
   - Inner buoy, lying E. S. E. ⅜ E. from the signal pole at Cape Kogo and N. N. W. ¾ W. from the surveying post at Kompira Mountain.
   - Middle buoy, lying S. E. ½ E. from the signal pole at Cape Kogo and N. W. by W. ¾ W. from the surveying post at Kompira Mountain.
   - Outer buoy, lying to E. by S. from Shirase and of N. by E. ¼ E. from Bansho Cape.
2. The line drawn S. E. by E. ½ E. from the inner buoy.
3. The line drawn S. E. from the outer buoy.

   The sea surface inclosed by the foregoing lines.

No. IV. Asami Bay, Tsushima Province:

1. The point lying 400 meters S. E. from the middle part of the line connecting Yuran Cape with Tan Cape.
2. The point lying 400 meters N. W. from the middle part of the line connecting Yuran Cape with Tan Cape.
3. The point lying 400 meters S. E. of Tan Cape.
4. The point lying 400 meters N. W. of Tan Cape.

   The sea surface inclosed by the lines which successively connect these four points.

No. V. The entrance of Kurose Harbor in Asami Bay, Tsushima:

1. The channel between Myoban and Henda islands.

No. VI. Koyaki channel at the entrance of Nagasaki Harbor:

1. The line connecting Onna Island with Cape Umenoki of Koyaki Island.
2. The line connecting the Tozo post with Onna Island.
3. The line drawn due north from the Tozo post.

   The sea surface inclosed by the foregoing lines.

No. VII. Koyaki channel at the entrance of Nagasaki Harbor:

1. The channel between Onna Island and Fukabori village.

No. VIII. Nashami channel in Hiroshima Bay:

1. The line connecting the western extremities of Kokurokami and Onashami islands.
2. The line connecting the eastern extremity of Kokurokami Island with the western extremity of Nishinomi Island.
3. The line drawn due south from the eastern extremity of Onashami Island.

   The sea surface inclosed by the foregoing lines.

No. IX. Hayase channel in Hiroshima Bay:

1. The line drawn due south from the southwestern extremity of Higashinomi Island.
2. The line drawn east and west passing the point 1 nautical mile 8 chains due north from the southeastern extremity of Higashinomi Island.

   The sea surface inclosed by the above two lines.

In one or two cases, at least, it is known that booms were rigged across the entrance to harbors in addition to the mines.

OFFICIAL RECORD OF THE NAVAL MANEUVERS.

The only known official record of the maneuvers obtainable is the following brief account published by the Japanese Navy Department:

Notes upon the Course of the Naval Maneuvers.

[Furnished by Japanese Navy Department, May 8, 1900.]

FIRST PERIOD.

The operations of the first part of the grand maneuvers consisted in the mobilization of the naval ports, and of the ships of war. These operations were commenced on the 27th March; in the early hours of the morning of that day the order to put in execution the plan of mobilization was simultaneously transmitted to the commander in chief at the ports.

The ports of Yokosuka and Sasebo completed the armaments of their ships on the 1st of April. The vessels thus equipped for war were concentrated in the port of Kure on the 2d of April, and on the 7th the ships comprising the offensive squadron proceeded to Kagoshima, where, from the 8th April, they were engaged in preliminary exercises.

SECOND PERIOD.

The actual operations of the second period were begun on the 16th of April. The following morning at daybreak the offensive squadron entered the Inland Sea by the Straits of Shimonoseki and encountered in the neighborhood of the Bay of Hiroshima some of the enemy's cruisers acting as scouts.

This day the offensive squadron passed the night cruising outside the Bay of Hiroshima, watching the enemy's movements. But the following day the defensive squadron, profiting by a dense fog and occasional showers of rain, succeeded in eluding the vigilance of the enemy and executed a sortie toward the south, passing through the Bungo Channel. After these operations the maneuvers were temporarily suspended.

On the 23d of April the two squadrons left, one for the eastern part of the Inland Sea, and the offensive squadron for the Tosa Sea. Two days later (on the 25th) the operations were resumed.

An encounter between the two squadrons took place on the 28th in the Kii Channel, from which the defensive squadron retired toward the Inland Sea and made attacks upon the invaders by means of torpedo boats.

At the close of these operations the grand maneuvers were suspended.

THE DIRECTOR OF THE MANEUVERS.

The scheme of mobilization, plan of operations, and all decisions as to defeat or victory were entirely in the hands of Admiral Viscount Ito, the hero of the victory at the Yalu. Admiral Ito, as chief of the naval commanding staff, is the direct naval advisor of the Emperor, which, with his actual rank (full admiral), makes him somewhat overshadow the Minister of Marine, who is only a vice-admiral (Vice-Admiral Yamamoto). In all events Admiral Ito had supreme command.

The approximate date of the operations was announced in the newspapers some months beforehand, so that the mobilization was robbed of much of the value it would otherwise have had. The actual orders for the mobilization were issued from the navy department at Tokyo at 4 a. m. March 27, 1900. The same day Admiral Ito and his staff left Tokyo for Yokosuka.

The following was the plan of mobilization, and the operations were performed in the order given: (1) The calling out of the naval reserves and the coaling of the ships in the reserve. (2) The summoning of extra hands to work in the dockyards. (3) The completion of all ships with coal, provisions, ammunition, stores, etc., as if for actual war. (4) Organization of signal and lookout stations round the coast, for war. (5) Protection of harbors and approaches by booms, submarine mines, etc. (6) Removing all portable fittings of wood from ships.

STATION OF SHIPS PRIOR TO THE MANEUVERS.

As nearly as possible the following table gives the position of all Japanese ships just prior to the maneuvers:

Standing squadron in commission in Japanese waters:
- Yashima, first-class battleship.
- Chinyen, second-class battleship.
- Akitsushima, second-class protected cruiser.
- Chitose, second-class protected cruiser.
- Takasago, second-class protected cruiser.
- Akashi, third-class protected cruiser.
- Idzumi, third-class protected cruiser.

Standing squadron in commission in Chinese or Korean waters:
- Suma, third-class protected cruiser.
- Akagi, third-class cruiser (unprotected).
- Tsukushi, third-class cruiser (unprotected).
- Atago, gunboat.
- Banjo, gunboat.
- Chokai, gunboat.
- Oshima, gunboat.

Yokosuka squadron, full crew on board, ready for sea at twenty-four hours' notice (except Musashi):
- Asama, first-class armored cruiser.
- Hashidate, second-class protected cruiser.
- Tatsuta, torpedo vessel.
- *Musashi, third-class unprotected cruiser (undergoing repairs).

Kure squadron, full crews on board, ready for sea at twenty-four hours' notice:
- Tokiwa, first-class armored cruiser.
- Yoshino, second-class protected cruiser.
- Chiyoda, small armored cruiser.

Sasebo squadron, full crews on board, ready for sea at twenty-four hours' notice:
- Fuji, first-class battleship.
- Kasagi, second-class protected cruiser.
- Takachiho, second-class protected cruiser.
- Miyako, third-class unprotected cruiser.

Vessels in reserve and repairing at Yokosuka:
- *Takao, third-class unprotected cruiser (in dry dock).
- *Heiyen, coast defense armored ship (extensive repairs).
- *Seiyen, third-class protected cruiser (extensive repairs).
- Amagi, wooden gun vessel.
- Chinto, gunboat.
- Yaeyama, third-class unprotected cruiser.
- Toyohashi, torpedo depot and store ship.

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*Ships marked thus (*) were not commissioned for the maneuvers.

Vessels in reserve and repairing at Kure:
- Fuso, coast-defense armored ship.
- *Naniwa, second-class protected cruiser (extensive repairs).
- Itsukishima, second-class protected cruiser (in use as a training ship).
- *Tenriu, third-class unprotected cruiser (extensive repairs).
- Yamato, third-class unprotected cruiser.
- Maya, gun vessel.
- Chinchu, gunboat.
- Chinpen, gunboat.

Vessels in reserve and repairing at Sasebo:
- Matsushima, second-class protected cruiser.
- *Katsuragi, third-class unprotected cruiser (extensive repairs).
- *Kaimon, third-class unprotected cruiser (extensive repairs).
- Chinsai, gunboat.
- Chinnan, gunboat.
- Sazanami, destroyer.

At Takashiki (Tsushima Island):
- Shiranui, destroyer.
- Yugiri, destroyer.

En route from England, arrived during the maneuvers:
- Shikishima, first-class battleship.
- Oboro, destroyer.

Of the ineffective vessels the *Tsukuba* was at Etajima as a training ship, and the *Soko* was at Naga-Ura.

The whereabouts of the torpedo boats and destroyers is difficult to locate, but they were probably in commission at their respective ports.

SHIPS SPECIALLY COMMISSIONED FOR THE MANEUVERS.

The following ships, so far as can be learned, are the only ones that were specially commissioned for the maneuvers. The place of mobilization and the number of officers and men are given:

	Yokosuka.	Kure.	Sasebo.
Shikishima (navigating to full crew estimated)		230	
Fuso		377	
Matsushima			355
Itsukushima (training to full crew estimated)		155	
Yaeyama	215		
Yamato		230	
Toyohashi	350		
Torpedo boats Nos. 33, 34, 35, and 36		92	
Chinpen		59	
Chinchu		59	
Amagi	159		
Chinto	59		
Chinhoku	59		
Chinnan			59
Chinsai			59
Maya		105	
Torpedo boats Nos. 5, 7, 8, 9, 10, 19, 20			112
Total	842	1,307	585

making a total of 2,734 officers and men.

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*Ships marked thus (*) were not commissioned for the maneuvers.

RESERVES.

Unfortunately no figures are available as to the exact number of reserves called out. The following table gives the reserve list on January 1, 1899, and may be of interest:

	Flag officers.	Commanding officers.	Officers.	Staff officers.	Petty officers.	Men.	Total.
First reserves	28	33	31	27	190	1,821	2,130
Second reserves	3	45	56	25	....	1,741	1,870
Total	31	78	87	52	190	3,562	4,000

In Japan the country is divided into districts, and each district furnishes its quota of reserves. The reserves seem to have been called only from certain districts, and even from these districts the number that actually reported is not known. On March 26 an order was issued calling the reserves from the Kioto, Osaka, and Kure districts, and on the 27th from the Hakodate and Takamatsu districts. On the 28th of March the reserves from the Shidzuoka district were called, and on the 29th those from the Utsonomiya district. On April 5, 442 reserves reported at Kure.

The reserve officers seem to have been employed only on shore and in connection with the mining of harbors, but of their actual service little can be learned. One of the local papers stated that the reserve officers began duty on April 6.

ADDITIONAL MEN IN THE DOCKYARDS.

The dockyard forces were all increased, so that the arsenals were put on a war footing and were able to work to their full capacity. At Kure the number of workmen was said to be 8,000. At Yokosuka on March 23 the vice-admiral commanding advertised for 400 additional workmen for the new naval port of Maidzuru, but there is some doubt about these men having been obtained, and certainly they were not sent to Maidzuru.

JUDGES AND UMPIRES.

As before stated, Admiral Viscount Ito was the supreme judge. His staff was very large, including about 50 officers, and every ship of both the attacking and the defending squadrons had an umpire on board. The principal assistant of Admiral Ito was Vice-Admiral Shibayama, the head of the Japanese Naval Academy, who was detailed to watch the progress of the operations from the southern naval base of Sasebo.

The following officers of different grades held positions as umpires, judges, or inspectors, though this list does not necessarily include all officers serving in that capacity: Four rear-admirals, 17 captains, 20 commanders, 11 chief engineers.

It is said that junior engineers were detailed for all engine rooms to watch the progress of affairs there.

Twenty-three officers of the general staff of the Japanese army were present on duty during the maneuvers. Some were on board ships and others watched the operations from the coast fortresses. Lieut. Gen. Baron Y. Oku, commander in chief of the military defenses of Tokyo, arrived in Kure on April 5 and witnessed the maneuvers from one of the ships.

NOTE.—The coast fortresses are in the hands of the army, but the navy is entirely responsible for the floating defenses and submarine mining everywhere in Japan.

THE COMMANDERS OF THE SQUADRONS.

Admiral Viscount Ito was the supreme director of the maneuvers.

Vice-Admiral Sameshima, the commander in chief of the standing squadron, held the maneuver appointment of commander in chief of the attacking squadron, with the *Fuji* as his flagship.

Rear-Admiral Tsunoda, second in command of the standing squadron, held the maneuver appointment of second in command of the attacking squadron, with the *Matsushima* as his flagship.

Rear Admiral Hidaka commanded a division of fast cruisers belonging to the attacking squadron at the maneuvers, with the *Asama* as his flagship.

NOTE.—At the review at Kobe Rear-Admiral Hidaka shifted his flag to the *Kasagi*, as the *Asama* was used by the Emperor.

Vice-Admiral Inoue, commander in chief at Kure, held the maneuver appointment of commander in chief of the defending squadron, and hoisted his flag on board the *Yashima*.

Rear Admiral Kataoka, second in command at Kure, and commanding the Kure squadron, held the maneuver appointment of second in command of the defending squadron, with the *Tokiwa* as his flagship.

Practically all the flag officers in the navy were connected in one way or another with the maneuvers.

COMPOSITION OF THE SQUADRONS.

The active operations of the maneuvers were divided into two distinct phases, for each of which the squadrons were rearranged. The first phase began on April 16 and ended with the escape of the blockaded fleet from Kure on April 19. (See official report.)

During these operations the squadrons were as follows:

Blockading squadron.	Blockaded squadron.	At Kure for coast defense (not actively employed).
Fuji, battleship.[1]	Yashima, battleship.[1]	Fuso, coast defense.
Chin Yen, battleship.	Tokiwa, armored cruiser.[1]	Chitose, protected cruiser.
Asama, armored cruiser.[2]	Takasago, protected cruiser.	Miyako, unprotected cruiser.
Chiyoda, armored cruiser.	Yoshino, protected cruiser.	Chinchu, gunboat.
Akitsushima, protected cruiser.	Akashi, protected cruiser.	Chinpien, gunboat.
Hashidate, protected cruiser.	Yamato, unprotected cruiser.	
Itsukushima, protected cruiser.	Tatsuta, unprotected cruiser.	
Matsushima, protected cruiser.[2]	Ikadsuchi, destroyer.	
Takachiho, protected cruiser.	Inadzuma, destroyer.	
Kasagi, protected cruiser.	Yugiri, destroyer.	
Idzumi, protected cruiser.	Shiranui, destroyer.	
Toyohashi, depot ship.	Kagero, destroyer.	
Yaeyama, unprotected cruiser.	18 torpedo boats.	
Murakumo, destroyer.		
Shinonome, destroyer.		
Akebono, destroyer.		
2 torpedo boats.		

[1] Flagship of commander in chief.

[2] Flagship of second in command.

From the above it is seen that the blockading or offensive fleet was greatly superior in heavy ships to the blockaded fleet, but greatly inferior in torpedo craft. This same disparity is noted later on.

The operations during the second phase of the maneuvers were to a large extent prearranged, and seem to have been largely a naval show for the Emperor.

Admiral Ito and his personal staff remained at Yokosuka until April 3, when he embarked on board the *Toyohashi* and proceeded to Kure. By this time almost all the entire mobilized fleet had gathered here, and the newly commissioned ships were inspected. On the 5th and 6th the different ships exercised at target practice and on the 7th the squadron separated, the defending squadron putting to sea for a week's preliminary evolutions and returning to Kure on the 14th. The attacking squadron left Kure on the 8th and arrived at Kagoshima on the 10th.

During the stay of the attacking fleet at Kagoshima, a merchant steamer, the *Miyajima Maru*, of about 1,200 tons, collided with the *Kasagi* on March 13. The *Miyajima Maru* was entering the harbor, and the cause of the accident was stated to be both the thick weather and the crowded condition of the harbor. No damage was done to the *Kasagi*, but the *Miyajima Maru* had to be beached to keep her from foundering.

PRELIMINARY EXERCISES.

The preliminary exercises referred to in the official account seem to have been simple tactical evolutions, while special attention was paid to the drilling of scouts. The torpedo boats and destroyers were drilled as distinct flotillas, and seem to have acquitted themselves well. Japanese officers expressed the opinion that destroyers of over 300 tons were most efficient vessels. Some minor breakdowns occurred, but nothing of importance or that was not to be expected.

Before taking up the maneuvers proper it is necessary to refer to the *Shikishima*. This vessel, built in England, reached Kure the day after the declaration of war, with a reduced or "navigating crew" on board. This crew was increased to her full complement at Kure on the 18th and the vessel joined the mobilized fleet on the 19th, too late, however, to take part in the first phase of the operations and in the sortie, so that it seems only fair to eliminate her from any calculations of the strength of the fleets during the first phase.

The *Fuso*, newly repaired and commissioned, was used during the first phase for harbor defense only and did not take part in the sortie. Hence, assuming the *Chiyoda* for maneuver purposes to be equal to the armored cruisers, we have the following state of affairs. The attacking fleet was noticeably stronger than its adversary as regards heavier ships, but inferior in torpedo craft. It seems fair to suppose that this condition of affairs was arranged to represent a foreign power, possibly Russia, attacking Japan, and having for its immediate objective the central naval port of Kure. In that case the attacking squadron would be sure to be weak in torpedo craft, as compared with the number of those craft in the Inland Sea, while it is not at all improbable that it would be stronger in heavy ships. Were the objective of such a squadron, operating from northern China, the port of Kure, at least a day could be saved by entering the Inland Sea through the Straits of Shimonoseki. This saving of time would be of the utmost importance, but the extreme risk of this undertaking, in view of the narrow and tortuous channel and the formidable character of the fortifications at Shimonoseki, forbids the shorter route. In actual war a squadron operating against Kure would be forced to take the safer, but more circuitous, route around the southern end of Kinshin and through the Bungo Channel to gain the Inland Sea. This route was adopted by Admiral Sameshima with the attacking fleet, despite the temptation to rush the Shimonoseki Straits, and thus gain a clear day's steaming, and it seems to be correct strategy and accurately indicates the course likely to be adopted by a squadron operating from a base in northern China.

FIRST PHASE OF THE MANEUVERS.

When, on the 16th of April, "war" was declared, the attacking squadron (4 armored, 9 unarmored, and 5 torpedo craft) was anchored at Kagoshima, and the defending squadron (2 armored and 5 unarmored vessels, with 23 torpedo craft) was at Kure.

The attacking squadron immediately put to sea, heading north along the eastern coast of Kinshin. In the defending squadron, Admiral Inoue detached four cruisers (*Takasago*, *Akasahi*, *Tatsuta*, and *Yamato*) early on the 16th to act as lookout vessels. Of these one was fitted for wireless telegraphy and was thus presumably able to keep in communication with the commander in chief. Eight torpedo craft left Kure the same day and were presumably also employed as scouts or lookouts. The scouts of the opposing fleets met early on the 17th among the outlying islands in the Bay of Hiroshima, and a destroyer and cruiser action was fought, but nothing can be learned of the details.

The weather on the 17th was unsettled, with occasional rain, and the passage of the blockading squadron across the Inland Sea must have been, under the circumstances, very risky. As the fleet approached the archipelago the opportunities for a torpedo attack by the defending fleet were splendid, and the attacking fleet could scarcely have repelled a combined attack without suffering heavy loss. But before night Admiral Sameshima seems to have had time to place his ships as desired, and the blockade was, in fact, established. The night was overcast and squally, and must have been an uncomfortable one for the blockaders, especially if they kept close to Kure. In view of the great danger from torpedo-boat attack, though, it is probable that Admiral Sameshima retired to the southward into more open waters for the night. At least one encounter took place between cruisers and destroyers the night of the 17th. However, so far as can be learned, no vessels were reported as having been torpedoed.

The following day the defending fleet, according to the official report, "profiting by a dense fog and occasional showers of rain, succeeded in eluding the vigilance of the enemy and executed a sortie toward the south, passing through the Bungo Channel." From the extremely vague accounts it would appear that the blockading fleet was not long in discovering that the opposing fleet had escaped and immediately gave chase and succeeded in bringing the blockaded fleet to action. Of this action, however, nothing can be learned.

SUSPENSION OF HOSTILITIES.

On the 19th hostilities were suspended and the fleets returned to Kure. Vice-Admiral Inoue relinquished command of the blockaded squadron and returned to his official residence at Kure. Rear-Admiral Kataoka shifted his flag from the *Tokiwa* to the *Yashima*, and assumed command of a reconstructed and much smaller defending squadron, consisting mainly of high-speed cruisers and torpedo craft. An imperial squadron was also formed to accompany the Emperor. The remainder of the ships, under Vice-Admiral Sameshima, were reorganized as attacking squadrön, whose rôle was to threaten the eastern entrance to the Inland Sea. The rearranged fleets were as follows:

Attacking fleet.	Defending fleet.	Imperial squadron.
Shikishima, battleship.	Yashima, battleship.	Asama (His Majesty on board).
Fuji, battleship.	Tokiwa, armored cruiser.	Miyako, flag of Admiral Ito.
Chinyen, battleship.	Takasago, protected cruiser.	Akashi.
Fuso, coast-defense ship.	Yoshino, protected cruiser.	Yaeyama.
Chiyoda, armored cruiser.	Kasagi, protected cruiser.	Kagero.
Akitsushima, protected cruiser.	Chitose, protected cruiser.	
Hashidate, protected cruiser.	Toyohashi, torpedo depot ship.	
Matsushima, protected cruiser.	5 destroyers.	
Takachiho, protected cruiser.	19 torpedo boats.	
Idzumi, protected cruiser.		
Yamato, unprotected cruiser.		
Tatsuta, gunboat.		
3 destroyers.		

The ships remained together at Kure from the 20th until the 23d. On the morning of the 23d the imperial squadron left for Kobe, arriving the same evening. On the 24th the defending squadron left Kure and stood to the eastward. This squadron was sighted off Kishinada Shasu, in Osaka Bay, on the 25th exercising at tactics, and here it anchored on the evening of the 26th. The attacking squadron left Kure on the 25th, passed out of the Inland Sea by the Bungo Channel, rounded the southern end of Shikoku Island, and was next heard of in the Kii Channel on the morning of the 28th.

THE SECOND PHASE OF THE MANEUVERS.

His Majesty the Emperor embarked on board the *Asama* at Meiki at 8.15 a. m. on the 28th and proceeded to the Kii Straits, accompanied by the four escorts already named. Quite a large staff of officers were with him, and these included the minister of marine, minister of war, minister of the home department, Field Marshal Marquis Oyama, and many others. Admiral Ito, flying his flag on the *Miyako*, also accompanied him.

The defending squadron joined the imperial squadron in Asaka Bay. At noon the two squadrons in company were seen standing southwest outside the Straits of Idzumi, along the coast of Awaji.

In the meanwhile the attacking squadron had reached Wakanoura Bay, about 10 miles east of the Idzumi Narrows. Here a sham battle took place, which was witnessed by the Emperor. This battle included a daylight torpedo attack, and was more of a spectacular display than a solution of any tactical problem.

The defending squadron retired from this attack through the Idzumi Straits and along the northwest coast of Awaji. The Emperor's squadron anchored in Kuroye Bay at 4 p. m. and shortly afterwards the attacking squadron anchored in the same bay.

That evening at 8.15 a torpedo attack was made by the defending flotilla upon the attacking fleet. Search-lights were used and much powder was burnt, the attack lasting about one hour. All firing had ceased by 9.30.

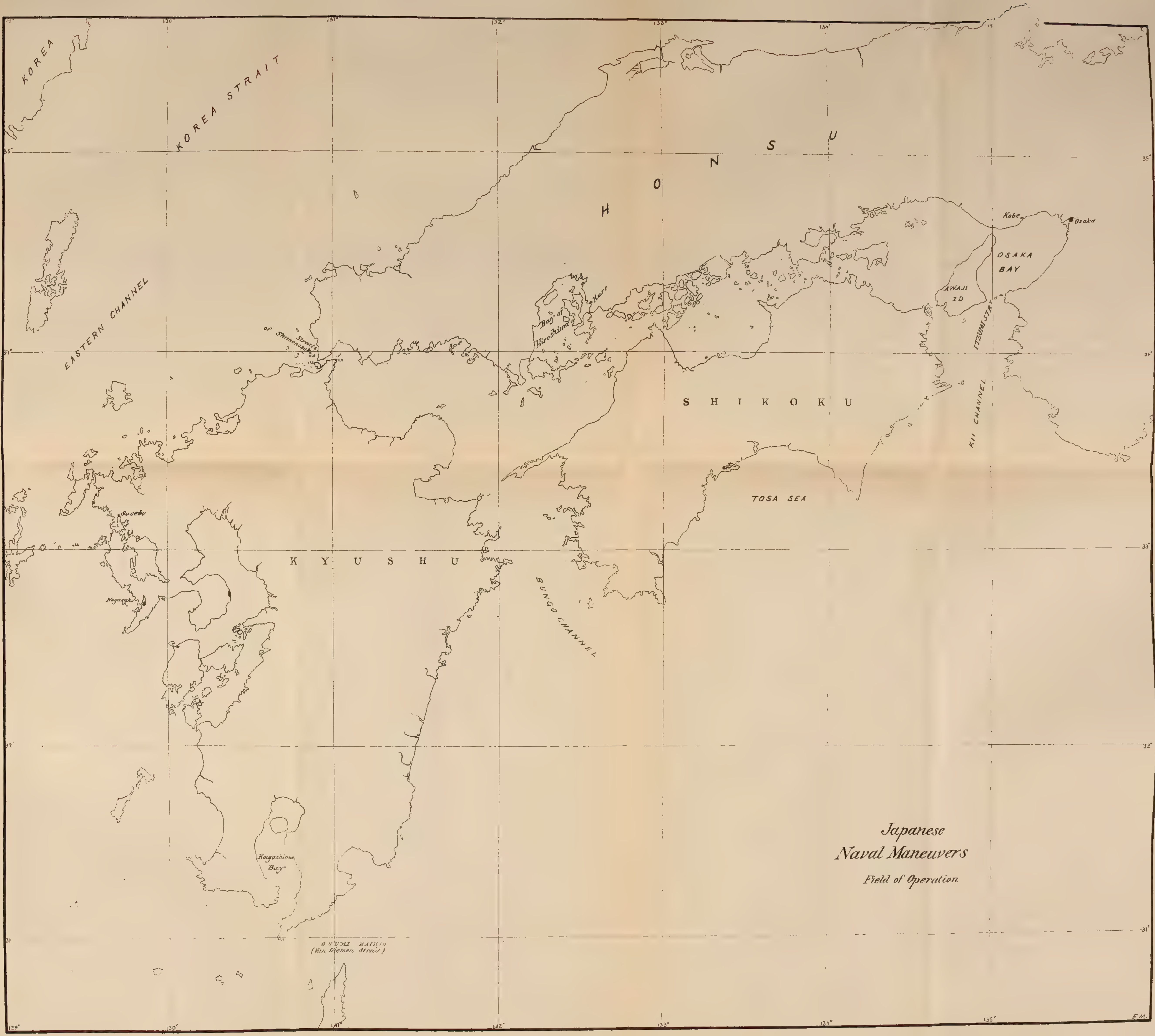
The next morning His Majesty the Emperor held an audience on board the *Asama*, at which all flag officers and captains were present and were complimented by the Emperor on the success of the maneuvers.

The *Asama* returned to Meiki the same afternoon, where His Majesty disembarked and the ships of the several fleets proceeded to Kobe to take up their appointed positions for the grand naval review to be held on the following day.

TABLE I.—*List of all sea-going ships commissioned and in Japanese waters during the maneuvers.*

Name.	Class.	Tons.	Complement.	Date of launch.	Remarks.
Shikishima[1]	First-class battleship	14,850	141	1898	Joined maneuvers Apr. 19.
Fuji	....do	12,450	658	1896	Flag Vice-Admiral Sameshima.
Yashima	....do	12,300	647	1896	Flag Vice-Admiral Inoue.
Chinyen	Second-class battleship	7,220	400	1882	
Asama	Armored cruiser	9,750	726	1898	Flag Rear-Admiral Hidaka.
Tokiwa	....do	9,750	726	1898	Flag Rear-Admiral Kataoka.
Chiyoda	Second-class cruiser	2,450	322	1890	
Fuso[1]	Coast defense	3,717	377	1877	Recently repaired.
Chitose	Second-class protected cruiser.	4,760	405	1898	
Kasagi	....do	4,784	405	1898	
Takasago	....do	4,160	385	1897	
Akitsushima	....do	3,100	314	1892	
Yoshino	....do	4,150	385	1892	
Hashidate	....do	4,210	355	1891	
Matsushima[1]	....do	4,210	355	1891	Flag Rear-Admiral Tsunoda.
Itsukushima[1]	....do	4,210	355	1889	
Takachiho	....do	3,650	352	1885	
Akashi	Third-class protected cruiser.	2,700	300	1897	
Idsumi	....do	2,920	298	1883	
Miyako	Third-class unprotected cruiser.	1,800	227	1897	
Yaeyama[1]	....do	1,583	215	1889	
Yamato[1]	....do	1,478	230	1885	
Toyohashi[1]	Depot ship	4,120	350	1888	
Tatsuta	Torpedo vessel	850	107	1894	
Shinonome	Destroyer	275	54	1898	
Murakumo	....do	275	54	1898	
Yuguri	....do	275	54	1898	
Shiranui	....do	275	54	1899	
Ikadsuchi	....do	260	54	1898	
Inadzuma	....do	260	54	1899	
Akebono	....do	360	54	1899	
Kagero	....do	275	54	1899	
Sazanami	....do	360	54	1899	At Yokosuka during maneuvers.
Kotaka	Division torpedo boat	203	28	1887	

[1] Ships were especially commissioned for the maneuvers.



Japanese
Naval Maneuvers
Field of Operation

Table I.—*List of all sea-going ships commissioned and in Japanese waters during the maneuvers*—Continued.

Name.	Class.	Tons.	Complement.	Date of launch.	Remarks.
Hayabusa	Torpedo boat	152	30	1899	
Fukuriu	do	115	20		
Nos. 32 to 36,[1] inclusive.	do	83	23	1898	
No. 31	do	83	23	1898	
Nos. 29, 30	do	88	23	1898	
No. 26	do	66	16		
No. 25	do	85	20	1895	
No. 24	do	85	20	1895	
No. 21	do	80	16	1892	
Nos. 12, 13, 17	do	54	16	1891	
Chinchu[1]	Gunboat	433	59	1881	Did not leave Hiroshima Bay during maneuvers.
Chinpen[1]	do	433	59	1881	Do.
Total		130, 275	10, 621		

[1] Ships were especially commissioned for the maneuvers.

Table II.—*Vessels commissioned during maneuvers, but not sent to sea.*

Name.	Class.	Tons.	Complement.	Date of launch.	Remarks.
Amagi[1]	Gunboat	911	159	1877	Harbor service, Yokosuka.
Chinto[1]	do	433	59	1879	Do.
Chinhoku[1]	do	433	59	1879	Do.
Maya[1]	do	613	105	1886	Harbor service, Kure.
Chinnan[1]	do	433	59	1879	Harbor service, Sasebo.
Chinsai[1]	do	433	59	1879	Do.
Nos. 5, 20[1]	Torpedo boat	54	16	1890	Local defense, Yokosuka.
Nos. 7, 8, 9, 10, 19[1]	do	54	16	1890	Local defense, Sasebo.
Total		3, 634	612		

[1] Ships were especially commissioned for the maneuvers.

Table III.—*Ships on foreign stations and training ships.*

Name.	Class.	Tons.	Complement.	Date of launch.	Remarks.
Kongo	Armored coast defense	2, 248	288	1877	Training ship naval cadets.
Hiyei	do	2, 248	288	1878	Do.
Tsukuba	Corvette	1, 978	233	1851	Stationary training ship.
Soko	Gunboat	610	112	1876	Torpedo training ship.
Bango	do	659	104	1879	Chemulpo, Korea.
Akagi	do	612	107	1888	Standing squadron, China.
Oshima	do	630	130	1891	Fusan, Korea.
Tsukushi	Unprotected cruiser	1, 370	190	1882	Standing squadron, China.
Suma	Protected cruiser	2, 700	300	1895	Standing squadron, Formosa.
Atago	Gunboat	612	105	1887	Standing squadron, China.
Chokai	do	612	105	1886	Do.
Total		14, 279	1, 962		

Table IV.—*Ships not commissioned, but for which crews were provided.*

Name.	Class.	Tons.	Complement.	Date of launch.	Remarks.
Naniwa	Second class protected cruiser.	3,727	357	1885	Under extensive repairs at Kure.
Saiyen	Third class protected cruiser.	2,320	180	1886	Under extensive repairs at Yokosuka.
Katsuragi[1]	Third class unprotected cruiser.	1,480	231	1885	Under extensive repairs at Sasebo.
Tenriu	do	1,550	214	1883	Under extensive repairs at Kure.
Ping-Yen	Coast defense	2,067	300	1890	Under extensive repairs at Yokosuka.
Musashi[1]	Unprotected cruiser	1,480	231	1885	Do.
Takao[1]	do	1,764	222	1888	Do.
Total		14,388	1,735		

[1] Ships were commissioned before the maneuvers were over.

	Tons.	Personnel.
Table I	130,275	10,621
Table II	3,634	612
Table III	14,279	1,962
Table IV	14,388	1,735
Add navigating crews for 1 battleship, 2 armored cruisers, and 3 destroyers, which had actually left for Japan	35,696	[1] 1,300
	198,272	16,230

[1] Approximate.

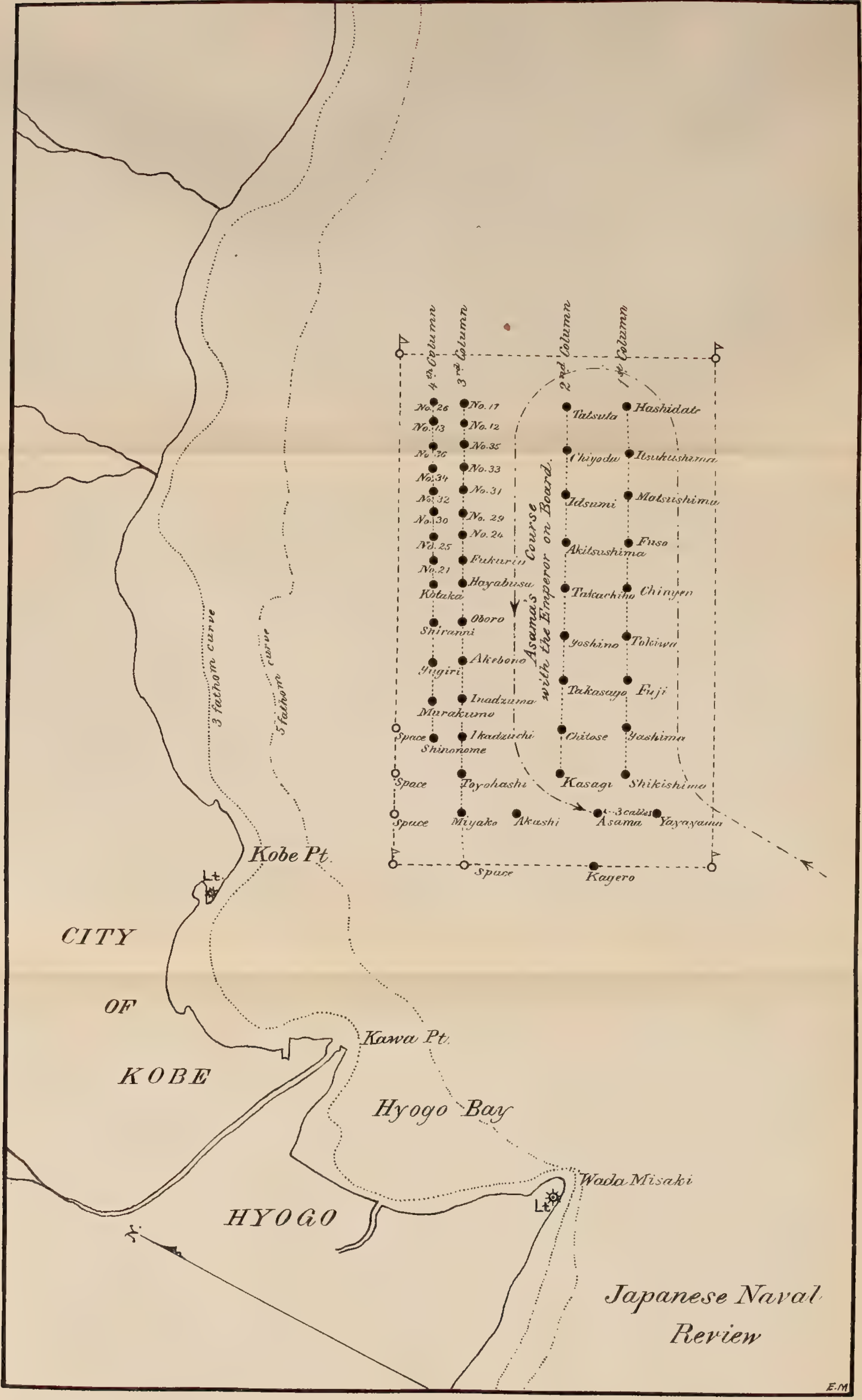
THE JAPANESE NAVAL REVIEW, KOBE, APRIL 30, 1900.

This review was held at the conclusion of the naval maneuvers and was witnessed by His Majesty the Emperor.

The position each ship was to occupy in the Bay of Kobe had previously been buoyed, and all ships were to lie at single anchor. On Sunday, April 29, at 1:30 p. m., the first torpedo flotilla, consisting of 8 destroyers and 9 torpedo boats, escorted by the *Toyohashi*, arrived. They entered the harbor at a speed of about 14 knots, but when near the anchorage stopped and lost all order, each one seeking its anchorage independently. About forty minutes later a second flotilla arrived, and it was fully 3 o'clock before they were all anchored.

At 3:15 p. m. the first squadron of heavy ships approached the bay in two columns, led by the *Fuji* and *Yashima*, and at 5 a second squadron came in. The heavy ships proceeded to find their places in the same manner as the torpedo boats, and it was 7 o'clock before they had all finally anchored. That night the ships tried all their electric illuminations.

No foreign men-of-war were present except the French cruiser *D'Entrecasteaux* and the Russian cruiser *Admiral Korniloff*, although there were a number of them at Yokohama.


4th Column
3rd Column
2nd Column
1st Column
No. 26
No. 13
No. 36
No. 34
No. 32
No. 30
No. 25
No. 21
Kotaka
Shiranni
Yugiri
Murakumo
Space
Shinonome
No. 17
No. 12
No. 35
No. 33
No. 31
No. 29
No. 24
Fukuriu
Hayabusa
Oboro
Akebono
Inadzuma
Ikadzuchi
Space
Toyohashi
Space
Miyako
Akashi
Asama's Course with the Emperor on Board.
Tatsuta
Chiyoda
Idsumi
Akitsushima
Takachiho
Yoshino
Takasago
Chitose
Kasagi
Hashidate
Itsukushima
Matsushima
Fuso
Chinyen
Tokiwa
Fuji
Yashima
Shikishima
Asama
3 cables
Yayayama
Space
Kagero
3 fathom curve
5 fathom curve
Kobe Pt.
Lt.
CITY OF KOBE
Kawa Pt.
Hyogo Bay
HYOGO
Wada Misaki
Lt.
Japanese Naval Review
E.M.

The Emperor reviewed the fleet from the deck of the *Asama*, which was followed by the *Akashi*, carrying all the foreign naval and military attachés and other invited guests.

According to the official program the Emperor, on board the *Asama*, left Maiko at 8 a. m., and about 9 entered Kobe Harbor. As the *Asama* entered the harbor every ship fired a salute of 21 guns. The *Asama*, followed by the *Akashi*, steamed through the fleet, as shown by the accompanying sketch, and as the Emperor passed the crews of all ships "manned the rail" and cheered him.

After the review the Emperor, with Admiral Viscount Ito, left the *Asama* and went on board the new battleship *Skikishima*, where he received the officers of the fleet and all invited guests. At this audience all the naval and military attachés, except the American and British, received decorations. The Emperor returned to the *Asama* at 3 p. m. and at 3:30 left for Maiko, all ships again firing a salute of 21 guns. In the evening the minister of marine gave a banquet, and the next morning, May 1, the ships began to disperse.

SECTION III.

FRANCE.

The French maneuvers last year were held during the latter part of June and the first part of July, terminating in a review at Cherbourg on July 19. The maneuvers themselves contained little that was instructive and were really nothing more than a series of sham battles and attacks on fortified ports, each event being carefully planned beforehand, and few or none of the elements of actual war being considered. The Northern and Mediterranean fleets made a junction early in July and held some combined maneuvers, but the result was mostly a spectacular show.

Vice-Admiral Jervis was the commander in chief, and during the maneuvers flew his flag as a full admiral on the *Bouvet*. The French regulations provide for the issuing of a temporary commission of admiral to a vice-admiral commanding a combined fleet.

The following is a list of the ships and flag officers participating in the maneuvers:

MEDITERRANEAN SQUADRON.

First-class battleships: *Bouvet* (flagship of commander-in-chief), *Brennus* (flagship of Vice-Admiral Fournier, commanding Mediterranean squadron), *Charles-Martel* (flagship of Rear-Admiral Roustan), *Charlemagne*, *Gaulois*, *Jauréguiberry*.

First-class armored cruisers: *Pothuau* (flagship of Rear-Admiral Marêchal), *Chanzy*, *Latouche-Tréville*.

Second-class cruisers: *Cassard*, *Du Chayla*, *D'Assas*.

Third-class cruisers: *Linois*, *Lavoisier*, *Galilée*.

Destroyers: *Dunois*, *Hallebarde*.

Squadron torpedo boats: *Cyclone*, *Forban*, *Flibustier*, *Chevalier*.

Torpedo depot cruiser: *Foudre*.

The reserve squadron was composed of the following ships:

Coast-defense battleships: *Bouvines* (flagship of Rear-Admiral Mallarmé), *Valmy*, *Amiral-Tréhouart*, *Jemmapes*.

THE NORTHERN SQUADRON.

First-class battleships: *Masséna* (flagship of Vice-Admiral Ménard commanding), *Carnot*, *Amiral-Baudin*, *Formidable* (flagship of Rear-Admiral Touchard), *Amiral-Duperré*.

Second-class battleship: *Redoubtable.*
First-class armored cruisers: *Dupuy de Lôme*, *Bruix.*
Third-class cruiser: *D'Estrées.*
Destroyers: *Fleurus*, *Cassini*, *La Hire*, *Durandal.*
Squadron torpedo boats: *Aquilon*, *Mangini.*

The first-class torpedo boats Nos. *180*, *185*, *186*, *201*, *203*, *204*, and *191* of the Défense-Mobile of Corsica were mobilized under Capitaine de Frégate Favereau, and took part in the maneuvers, accompanying the fleet to the north.

THE MEDITERRANEAN SQUADRON.

Preliminary maneuvers in the Mediterranean began as early as May. On the 26th of that month the squadron left Gulf Juan and divided into two squadrons. These squadrons seem to have been composed of all the battleships and coast-defense vessels on one side and the cruisers on the other, with a number of torpedo boats attached to each squadron. The squadrons met and maneuvered at a speed of 10 knots during the action, which lasted an hour and a half. The commander in chief maneuvered so as to bring the cruisers in column between the battleships and the coast-defense vessels. It is not clear what lessons were learned by subjecting the nine cruisers, only three of which were armored, to the fire of a greater number of battleships for an hour and a half by limiting the speed to 10 knots, thus depriving the cruisers of their special quality. The torpedo boats seem to have accomplished nothing. After the engagement the vessels returned to Gulf Juan. both sides claiming the victory.

The squadron left Gulf Juan on May 31. The next event of the program was an attack on the port of Ajaccio, Island of Corsica. Several ships were supposed to be anchored in the bay, and the port was further defended by six torpedo boats. On the night of the 31st a division of cruisers and torpedo boats was sent ahead to blockade the harbor. The torpedo boats were divided into two groups, one at either entrance to the bay. The torpedo gunboat *Dunois* entered the harbor and enticed the six torpedo boats to follow her out. They attacked the cruisers and successfully torpedoed several vessels. However, at daylight they found themselves surrounded by the remaining cruisers and the two divisions of torpedo boats and were considered captured. The battleships took no part in the action.

From Ajaccio the squadron went to Toulon, and left the latter port on the 21st of June for Oran, where they arrived on the 26th. The squadron of coast-defense battleships attacked the Algerian coast, which was defended by the torpedo boats of the Algerian mobile defense. The remainder of the ships were divided into two squadrons and executed various maneuvers on the way from Toulon to Oran.

After coaling at Oran the squadron passed out the Strait of Gibraltar and on July 2 rendezvoused with the Northern Squadron off the coast of Portugal.

THE NORTHERN SQUADRON.

The Northern Squadron began preliminary exercise early in June in the neighborhood of Belle Isle. On the 5th of the month the squadron was divided into two squadrons, A and B, one of which, B was to prevent the other, A, from entering the roads of Palais, Belle Isle, a friendly port, where it was to obtain supplies. A squadron was composed of the battleships *Masséna* and *Carnot*, the cruisers *Guichen* and *Dupuy de Lôme*, and two destroyers. The B squadron was composed of the battleships *Formidable*, *Amiral Duperré*, *Redoubtable*, the cruisers *Bruix* and *D'Estrées*, the torpedo gunboat *Cassini*, and a destroyer. The torpedo boats were at Palais and were to attack the B squadron in order to facilitate the entrance of the A squadron, which had the choice of two entrances. Whether or not the A squadron was prevented from entering the roads is not known.

The Northern Squadron continued to exercise at sham battles and bombarding forts until the 29th, when they sailed south from Brest, and joined the Mediterranean Squadron on July 2.

THE COMBINED OPERATIONS.

After the junction of the two squadrons the fleet started north, divided into four squadrons. On the way a sham battle was fought with no practical results.

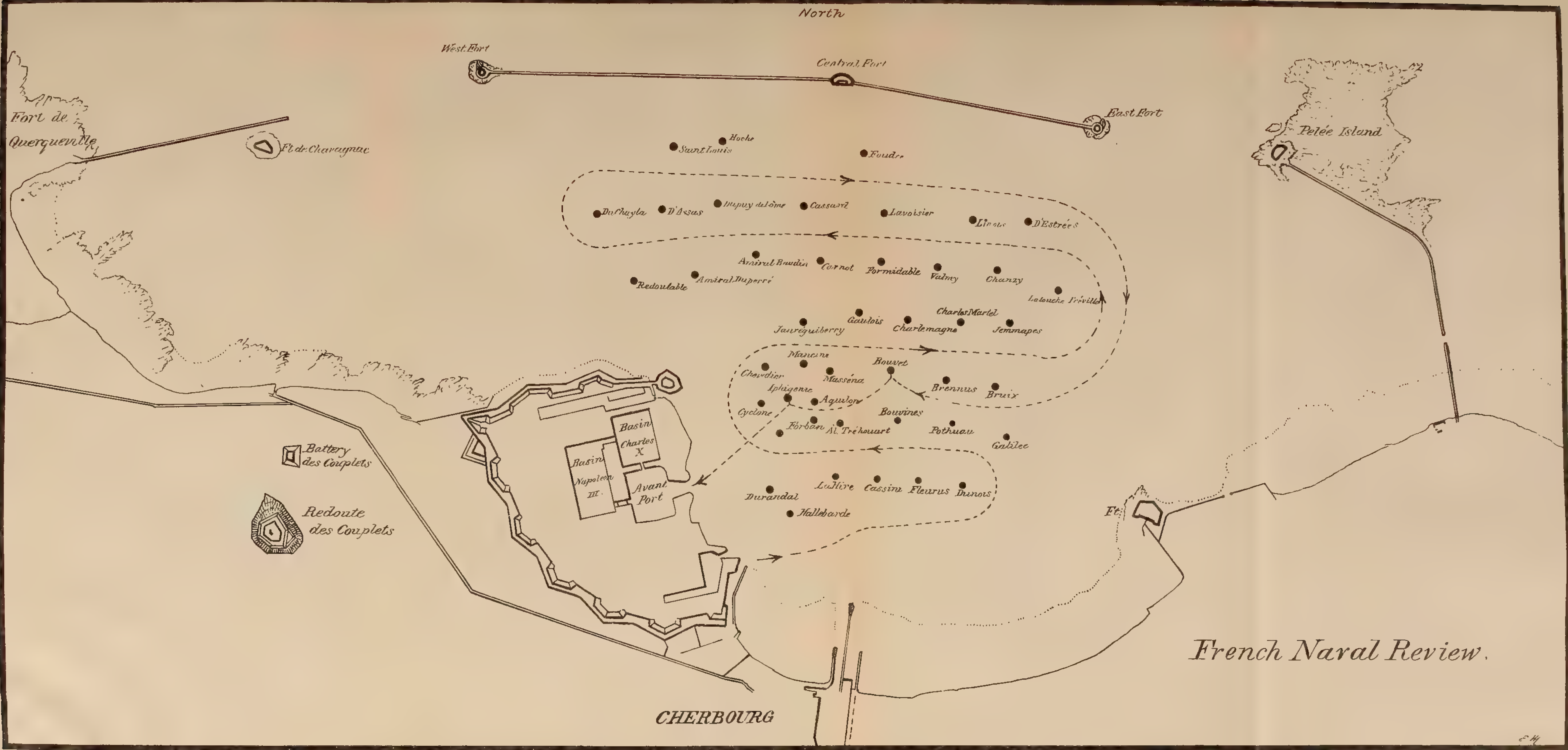
On July 8 the fleet anchored in the Bay of Douardenez, south of Brest. During the night the following program was carried out. A fleet was supposed to anchor in daytime off a hostile coast, the torpedo boats of the defending force knowing its position. The fleet established a line of outposts to seaward and used its search-lights toward the shore. The torpedo boats of the defense attacked the fleet during the night.

The first and second attacks, at about 11:50 and midnight, were repulsed. In the third attack, at about 1 a. m., the battleships *Jauréguiberry* and *Charlemagne* were torpedoed.

The next day the fleet got under way and anchored that evening in the Roads of Brest. Leaving Brest on the 10th they proceeded to Cherbourg and attacked the forts that guard that harbor. After much cannonading the ships entered the harbor and took their places for the grand naval review that was to terminate the maneuvers.

THE REVIEW.

The review was held at Cherbourg on July 19, when the President reviewed the combined fleet of 43 vessels. The accompanying plan of



French Naval Review.

the harbor gives the position of all the ships and the route taken by the President.

At noon the President embarked on the dispatch boat *Élan* and, followed by four other vessels with invited guests, reviewed the fleet. Then the President went on board the *Bouvet* and congratulated Admiral Jervis and distributed numerous decorations. Later the President witnessed some trials of the submarine torpedo boats *Morse* and *Narval.*

SECTION IV.

GERMANY.

The German naval maneuvers began at Wilhelmshaven on August 15, 1900, and ended September 15, 1900. The first part of the maneuvers took place in the North Sea and the latter part in the eastern and central Baltic. Owing to the fact that the four battleships of the *Brandenburg* class and several cruisers had been dispatched to China, the effective strength of the maneuver fleet was greatly reduced.

Following is the list of ships that participated in the maneuvers:

Battleships: *Kaiser Wilhelm II*, *Kaiser Friedrich III*, *Württemberg*, and *Sachsen*.

Armored coast-defense ships: *Aegir*, *Odin*, *Heimdal*, *Hildebrand*, *Siegfried*, and *Frithjof*.

Aviso: *Grille*.

Dispatch boat: Torpedo boat *S–40*.

Small cruisers: *Greif*, *Jagd*, *Blitz*, and *Pfeil*.

Special ship: *Pelikan*.

Torpedo division boats: *D–5*, *D–7*, *D–8*, *D–9*, and *D–10*.

Torpedo boats: *S–44*, *S–45*, *S–47*, *S–50*, *S–52*, *S–57*, *S–67*, *S–68*, *S–63*, *S–93*, *S–69*, *S–70*, *S–71*, *S–73*, *S–58*, *S–59*, *S–61*, *S–62*, *S–65*, *S–94*.

Harbor ship: *Friedrich Karl*.

School ships: *Mars* and *Carola*.

Armored gunboats: *Skorpion*, *Natter*, *Mücke*, and *Crocodil*.

For the second part of the operations the ships were divided into two squadrons, as follows:

YELLOW SQUADRON—UNDER REAR-ADMIRAL VON ARMIN.

Battleships: *Aegir*, *Heimdal*, *Siegfried*, *Hildebrand*, *Sachsen*, and *Württemberg*.

Cruisers: *Greif* and *Carola*.

Transports: *Mars* and *Friedrich Karl*.

Torpedo boats: One flotilla of torpedo boats.

GERMAN PARTY UNDER REAR-ADMIRAL BUCHSEL.

Battleships: *Kaiser Friedrich III*, *Odin*, and *Frithjof*.

Armored gunboats: *Skorpion*, *Natter*, *Mucke*, and *Crocodil*.

Cruisers: *Jagd*, *Blitz*, and *Pelikan*.

Torpedo boats: One flotilla of torpedo boats.

The four armored gunboats and the *Odin* were designated to assist in the defense of the fortifications of Swinemünde. In the rough weather experienced in the North Sea the new torpedo boats *S–93* and *S–94* proved to be much better sea boats than the older torpedo boats.

The following account of the maneuvers is quoted from the London *Times:*

> The earlier portion of the program consisted of inspection, drill, etc. After a day in Wilhelmshaven, the tactical exercises were begun, varied by attacks of the torpedo boats at night. The latter seem to have been frequently successful, but it must be remembered that the position of the force to be attacked was probably communicated to the attackers or, at any rate, very easily discoverable. On August 23 the mouth of the Jade was found to be defended by a field of mines at a distance of 7 miles from Wilhelmshaven. Torpedo boats were detailed to remove them and the defense was undertaken by boats manned by naval artillerists, with what result is not stated. The fleet then put into Wilhelmshaven and coaled. The next event was an attack on Cuxhaven. On the afternoon of the 24th two torpedo boats were observed endeavoring to steal into the harbor under cover of a chance steamer—a device somewhat useless in case of war—and repelled, one being disabled. At midnight the fleet itself attacked, and cannonaded the forts, which replied. The following day saw the start for the Baltic. Off Skagen the *Kaiser Friedrich III* was told off to do duty as a cruiser and lead the torpedo boats to the attack of the first squadron. In semidarkness the boats mistook the *Kaiser Wilhelm II* for their consort, and gave the private signal; they seem to have been driven off and failed to find the remainder of the first squadron, which was out of sight. The fleet advanced through the Belt in scouting formation; in the evening the two ships of the *Kaiser* class endeavored to pass the line unperceived; they separated, and in the end only one was detected. The operation was, however, naturally of a rather unreal character. In time of war no commander would dream of dividing his forces for such a purpose, especially at night, in the face of an enemy of unknown force. After some further evolutions, varied by torpedo-boat attacks, the fleet put into Neufahrwasser to coal and renew boiler water.
>
> The period from September 3 to September 8 was occupied with tactical exercises in the eastern Baltic. A move was then made to Swinemünde, where the officers took part in the parade of the army before the Emperor. September 10 and 11 were occupied with further tactical exercises in Stettin Bay, and the three following days saw the concluding strategical maneuvers. The general idea of these was "Germany is at war with a power superior at sea." The special idea was "a hostile fleet, coming from the east, intends to land troops on the island of Rügen. Stettin and Swinemünde are besieged. The hostile fleet has to silence the sea defenses of Swinemünde. The German fleet has the task of interrupting or preventing these operations." In addition to the ships already mentioned, the training ships the *Mars*, the *Carola*, and the *Friedrich Karl*, together with four antiquated gunboats, now joined the fleet, which was divided into two sides, the German and the "yellow;" the *Kaiser Wilhelm II*, being the umpire's (Vice-Admiral Hoffmann's) ship, was neutral; the four gunboats and the *Odin* were detached to strengthen the sea defenses of Swinemünde; the remainder so distributed that the German fleet was weaker both numerically and as a fighting force. The German admiral disposed his forces on either side of Bornholm to prevent the passage of the "yellow" fleet. The latter attempted the southern side on the morning of September 13, and though the German admiral succeeded in concentrating his forces in the short space of two hours, the enemy forced the passage with the loss of two ships. The "yellow" leader then sent

his transports on, his primary object being, of course, to secure the landing. The battleships then kept the pursuing German fleet at bay and in the course of the operations succeeded in disabling several cruisers. On nearing the coast of Rügen the "yellow" leader ordered an attack on Sassnitz, to secure possession of the railway. Meanwhile the *Kaiser Friedrich III* and the *Frithjof* in attempting to prevent the landing of troops engaged four ships of the nominal value of the *Kaiser* class. The *Frithjof* was soon disabled and the *Kaiser Friedrich* had to withdraw so far disabled that her speed was limited to 5 knots for the next five hours instead of the maximum of 11 knots which was laid down for the battleships. This loss of speed passed unnoticed by the "yellow" ships, however, who rejoined their own forces without attempting to capture their disabled adversary. The troops were then landed without opposition. It was now so late that a bombardment of Swinemünde was hardly possible. The "yellow" fleet therefore weighed anchor after repairing damages and remained all night under steam in expectation of an attack which did not take place.

Early the following morning the "yellow" fleet advanced to the bombardment in line abreast. Changing course eight points to starboard before coming within range of the forts, they found themselves attacked from the sea side by the German fleet; the "yellow" leader, however, trusting to his superior strength, continued his attack on the forts, and succeeded in putting two of the gunboats out of action. Thereupon the *Odin*, with even less prospect of success than the Spaniards at Santiago, made a despairing effort to escape and join the German fleet outside, but was naturally quickly put out of action, as were also the two remaining gunboats. While the "yellow" fleet, farther to the east, was engaging the forts, a second attempt at escape was made, this time by a torpedo boat, which, having secured a good start, successfully showed its heels to the pursuer. The forts were now left to fight the enemy alone; what the result would have been it is difficult to say in the absence of detailed information. The aims of the operation having, however, been attained, the signal for the close of the operations was given.

As in the previous year, the final operations involved a great deal of "make-believe;" there is thus a certain air of unreality about them. The maximum speed for battleships was exceedingly low, and as has been already stated large cruisers were conspicuous by their absence. The German commander seems to have made no attempt to harass the enemy with his torpedo boats, even on the night of September 13, and nothing seems to have been done by the German cruisers to stop the transports when they had forced the passage. If the German fleet was so strong, as it must have been by hypothesis, as to be able to watch both sides of Bornholm, it is clear that a few cruisers might well have been kept back for this purpose. Again, the "yellow" fleet, even after losing two ships to the German three or four, can not well have been so superior as to be able to risk an engagement with forts and fleet at once. The unreal element in the operations seems on the whole to have been too prominent for any lessons of great value to be drawn from them, at any rate by those who were not in a position to follow the strategy from inside.

VII.

TRANSPORTATION OF THE GERMAN EXPEDITIONARY FORCE TO CHINA.

[Translated in the Office of Naval Intelligence from the *Militär-Wochenblatt.*]

By imperial cabinet order dated July 9, 1900, His Majesty the Emperor ordered the organization of an expeditionary force to be formed of volunteers of the army and to consist of 8 battalions of infantry, 3 squadrons of cavalry, 4 batteries of field artillery, and the necessary special arms, ammunition columns, and trains.

On July 17 and 18 the staffs and commanding officers of troops were able to report to the commander in chief of the expeditionary force that the organization had been completed; and the departure of the expeditionary force, embarked in ten steamers, took place between July 27 and August 4. The force was composed as follows: 500 officers and superior officials, 10,894 petty officers and men, 558 guns and vehicles, 594,335 cubic feet of effects and military stores.

In the same manner a reenforcement ordered by imperial cabinet order of August 12, 1900, consisting of 269 officers and superior officials, 7,430 petty officers and men, 303 guns and vehicles, 495,526 cubic feet of effects and military stores, left between August 31 and September 7, embarked in eight steamers.

The transportation of such large numbers of troops across the ocean was an entirely new experience for Germany. There were no preparations nor precedents; everything had to be improvised. It had been the intention, it is true, during the imperial maneuvers in 1900 to forward a mixed brigade of 4 battalions, 1 squadron, and 1 battery from Danzig to Swinemünde, and to this end a draft of "Sea Transport Regulations" was being prepared. The sudden outbreak of the troubles in China and the wholly unforeseen necessity of sending at once a large military force to that country put an end to all theoretic deliberations and rendered prompt action imperative.

Both the army and the navy had a share in conducting the transportation. No orders were issued accurately defining the jurisdiction of either, since it is impossible to separate military interests from technical naval interests.

The most important factor that makes it possible to transport large bodies of troops promptly and comfortably across the sea is an efficient merchant marine, and in this respect Germany was in the fortunate position of having at her disposal the two largest steamship companies in the world, the Nord Deutscher Lloyd and the Hamburg-American Company.

In conferences between the representatives of the army, the navy, and these two companies, the principles which were to govern the whole transport were laid down, and the measures hereinafter set forth, based on an inspection of the respective localities, were agreed upon.

Transport steamers were furnished in accordance with the provisions of special contracts, which, taking into consideration all possible contingencies, regulated the obligations to be assumed by the steamship companies and the compensations to be paid therefor by the Government.

The following requirements were made as to the equipment of the transports:

1. In the way of quarters the companies had to provide:

(*a*) For each officer from the rank of field officer up, and for each official of corresponding rank, for his exclusive use, a well-appointed stateroom, furnished with a large bureau that could be locked and some contrivance suitable to be used as a writing table.

(*b*) For each of the other first-cabin passengers likewise a well-appointed stateroom, as far as practicable, but, if necessary, from two to four persons were to share a stateroom furnished and equipped accordingly.

(*c*) For second-cabin passengers staterooms for from two to four persons each and a common mess room.

(*d*) For steerage passengers bunks in an inclosed space between decks having sufficient light and good ventilation.

2. The staterooms were to contain stationary berths for all the occupants, and, as far as practicable, a washstand and a camp chair for each passenger. The bedding was to consist of a mattress filled with horsehair or sea grass, a horsehair bolster, two woolen blankets, with linen or cotton covers, and a sheet and pillowcase.

3. For the safe-keeping of valuables, uniforms, etc., each cabin passenger was to be provided, as far as practicable, with locker space that could be kept under lock and key. Valuables and money could be handed for safe-keeping to the purser or the captain of the ship, and the companies were to be responsible for any damage or loss not occasioned by superior force.

4. All the staterooms and living quarters of the cabin and steerage passengers were to be equipped with steam heating apparatus.

5. The bunks in the steerage were to be numbered consecutively, beginning forward. For each two bunks two or three clothes hooks were to be provided, either secured to the bunks themselves or, near them, to the sides of the ship or the bulkheads.

6. All bunks not required for the accommodation of the men embarked were to be removed. In the space thus gained tables and benches were to be set up. In addition thereto the companies were to furnish a number of tables and benches to be set up on deck. Each of the tables in the men's quarters was to be marked with two consecutive numbers, and below these with the numbers of the men assigned to the table, as for instance:

Mess. I.	Mess II.
Nos. 1 to 12.	Nos. 13 to 24.

The electric lights below the deck were to be provided with shades, so as to prevent the bright light from shining directly in the faces of the men lying in the bunks.

7. To prevent accidents in case of collision a sufficient number of broad ladders leading from the living quarters to the deck were to be provided.

8. For each porthole a port ventilator was to be furnished; and for the hatches, wind-sails, as follows:

(*a*) In the lower steerage, for each room of 7,063 cubic feet air space or less, one wind-sail; for each room of 7,063 to 14,126 cubic feet, two wind-sails; and for rooms of over 14,126 cubic feet, three wind-sails.

(*b*) In the upper steerage, for each room of 10,594 cubic feet air space or less, one wind-sail, and for rooms over 10,594 cubic feet, two wind-sails.

The cross section of the wind-sails was to be at least 3.2 square feet, the length to be such that when the lower edge was about 1 yard from the floor of the room in question the upper end would project above the superstructures on deck.

9. Provisions were to be made for the erection of a sufficient number of gun racks in spaces not occupied by the men. The gun spaces were to be numbered consecutively, beginning forward. In order to facilitate the finding of any number, the numbers comprised in each group were to be shown above the rack, as for instance: Nos. 40 to 57.

10. For the officers' baggage and men's bags clothes rooms were to be provided, subdivided, if practicable, into compartments, allowing each officer 35.3 cubic feet of space and each man 10.6 cubic feet. These rooms were to be easily accessible during the voyage.

For the storing of saddles and harness, special compartments, accessible during the voyage, were to be provided.

11. For keeping the mess gear substantial shelves with raised edges were to be secured to the ship's sides above the mess tables. The mess gear for the personal use of the men, including plates, spoons, and forks, was to be furnished by the companies.

12. The companies were to furnish sufficient cleaning utensils and material, including soap, dish towels, etc.

13. Each steamer was to have one or two compartments fitted up as offices that could be locked.

14. Each steamer was to have hospital appointments, including a bath and water-closets, with accommodation for 2½ per cent of the total number of men embarked.

The hospitals were to be so located as to admit light and air directly and to be equipped with good heating apparatus. As far as practicable each hospital was to be furnished with suitable seats and a table for patients not confined to their beds.

The linen required for the hospital was, upon the request of the physician, to be furnished free of charge from the ship's stores.

15. Special care was to be devoted by the companies to the perfecting of the fire-extinguishing apparatus. Adequate provisions were to be made for life-saving purposes, and a sufficient number of boats, life-buoys, including one night life-buoy and material for constructing rafts, were to be carried on board. The companies were to furnish life-belts for all on board.

16. The companies were to equip each steamer with a steam launch, the *Rhein* with two.

17. The open space on deck was to be protected by high awnings, and was not to be obstructed by the storage of provisions or anything else.

If practicable, all boats were to be carried outboard, and the boiler rooms were to have screens on the sides to protect the passengers from the escaping heat.

18. For drying clothes a sufficient number of clotheslines was to be furnished the men.

19. A sufficient number of water-closets was to be furnished and the daily flushing and disinfection of the same provided for.

20. One or two letter boxes were to be furnished for each ship.

21. On each ship three suitable compartments for use as cells for prisoners were to be provided, separated from the living quarters of the men.

In addition to the foregoing, the contracts contained minute provisions relative to the food supply on board, including the prices of special articles of food and drink, the care of the sick, the transportation of effects, the time of readiness of steamer, stay in port of disembarkation, etc. Of these agreements we shall only mention that the people to be transported bore to the officers of the ship merely the relation of passengers; that the commander of the expeditionary force was empowered to retain the ship, even after the disembarkation of the troops and effects, as long as the military conditions required; that each steamer had to carry provisions for one hundred and fifty days, and that anything left over after the disembarkation was at the disposal of the field-commissary department. The safe stowage by experienced stevedores of all articles to be shipped, devolved at the port of departure upon the steamship companies, while at the port of disembarkation the companies only had to lend such assistance as usually falls to the share of the steamer crew in unloading.

On July 13, 1900, the ministry of war issued regulations to govern the departure of the East Asiatic expeditionary force, of which we mention the most important ones, as follows:

1. Bremerhaven was designated as the port of departure, as it was deemed expedient, in the interest of uniformity in the embarkation, to have all the troop transports sail from one German port. The only ports considered in this connection were Bremerhaven and Hamburg, being the headquarters of the two great steamship companies which, with their personnel and appliances, were to arrange, equip, and load the steamers.

As compared to Hamburg, with its enormous traffic and extensive works, Bremerhaven offered much easier conditions for the embarkation of the troops. The harbor, completely inclosed and not very large, facilitated organization and supervision. A clear and simple network of railroads rendered it possible to convey the troops and stores promptly and safely to any wharf, and interruptions of work from large crowds was less to be feared than at Hamburg.

Against the choice of Bremerhaven as the sole port of embarkation was the circumstance that the working force of the Hamburg-American company could not be utilized to the full extent, as it was not considered practicable, in view of prevailing labor conditions, to send the necessary force of stevedores with the ships, which were to arrive at Bremerhaven on certain days fully equipped and furnished in accordance with the terms of the contracts. The Lloyd, however, declared itself ready, with its own force, to take charge of the loading of the Hamburg steamers also.

2. For the embarkation proper, the following regulations were issued:

(*a*) All the staffs, troops, etc., vehicles, ammunition, and all such effects as the troops brought directly with them, such as officers' baggage, men's bags, etc., were to be conveyed by rail to Bremerhaven.

(*b*) All other military supplies, to be shipped as piece goods, were to be forwarded to the Weser Station, in Bremen. Thence they were to be taken on lighters down the Weser to Bremerhaven and placed alongside the transports. This extremely important provision was made in accordance with a request of the Lloyd, which deemed the simultaneous loading of the steamers from the wharf and from lighters absolutely necessary in order to finish the loading of the transports within the short time available. Thanks to this measure, the stowing of the cargo could be adapted to the methods practiced in ordinary traffic, and it became possible to utilize the resources which

Bremen affords in the way of workmen and sheds for magazine purposes, of which there is a scarcity in Bremerhaven. Moreover, for the loading itself, the hoisting apparatus of the steamer and that of the wharf could be operated simultaneously, and advantage could thus be taken of the ease with which loading is effected from lighters as compared with loading from a wharf, where each parcel must first be unloaded from the railway cars and put down on the wharf.

As to the stowing of the cargo, two principles had been laid down by the military authorities and were embodied in the regulations.

In the first place, all that part of the equipment of each body of troops which would be immediately required after the disembarkation—that is to say, their weapons, ammunition, clothing, stores, vehicles, etc.—was to be loaded on the same steamer with the body to which it belonged. Each ship was also to carry an extra supply of ammunition and provisions sufficient to last for some time after disembarkation; so that, if it should unexpectedly happen that but one steamer was unloaded, the troops would be supplied with everything necessary. The other requirement was that the cargo should be stowed on board each ship, as far as practicable, "in a warlike manner," that is to say, so that the reserve stores were stowed in the lower parts of the ship, and the other supplies above them in the order in which they would be required by the troops, those articles which would be immediately needed being nearest the top, where they were easily accessible. Besides, articles belonging together, such as vehicles and their contents, were to remain together, and the whole cargo of the ship was to be divided in accordance with the division of the troops.

The compliance with the latter principle—"the warlike loading" of each steamer—was rendered very difficult, not to say impossible, by the separation of the piece goods from the remainder of the military stores before the embarkation. Therefore, the military administration was willing to consent to the bulk freight—that is to say, the military supplies and stores not belonging to any particular division of troops, such as reserve provisions and the like—being conveyed to Bremen, but not the effects and stores belonging directly to the troops, including, for instance, the contents of the vehicles which had been packed for sea transportation.

This met with the objection that the endeavor must be to stow the bulk freight first in the lower compartments, and that the whole measure would be of advantage only if it comprised the greater part of the piece goods of the troops; that the ideal of "warlike stowage" could, in any event, be attained only to a very small degree, and then only if the best utilization of the space were renounced and a great deal of time were available for careful, systematic stowing; that after the unloading of the cargo at the port of disembarkation, the goods would have to be assorted ashore anyway, so that the warlike stowage of the cargo was of but questionable practical value, which was far outweighed by the above-mentioned advantages which would arise from conveying all piece goods on lighters from Bremen to Bremerhaven.

These grounds were deemed conclusive. But in order to make sure that the troops would have their most important effects and stores close at hand during the transportation and after the disembarkation, it was ordered that a portion of them, such as officers' baggage, men's bags, etc., was not to be sent to Bremerhaven until after the stowing of the cargo, arriving there together with the troops, and that other articles, such as emergency rations, a portion of the ammunition, medicine chests, and hospital wagons—the only vehicles which were stowed with their contents—should be kept separate in easily accessible places.

3. In order to facilitate assorting during the loading and unloading, all the effects and military stores belonging to a body of troops were to be marked with the number of that body and the name of the steamer on which, according to the schedule of embarkation, the body in question was to be transported. In the case of articles packed in boxes, etc., the contents were to be marked on the outside.

4. At Bremen and Bremerhaven collecting stations were established where all the articles arriving by rail were assorted and made ready for shipment. Each of these stations was under the command of a station master, assisted by an adequate force of officers, officials, and workmen.

The collecting station in Bremen comprised the office of the station master, a collecting magazine, a clothing depot, and a freight depot. Attached to it was the headquarters for the reception of free gifts to the soldiers, organized by the inspector-general of the volunteer hospital corps. The collecting station at Bremerhaven comprised the office of the station master, an ammunition depot, and a freight depot. These different departments had the same duties to fulfill that would devolve on them in case of mobilization, taking into account the special conditions of the case.

For regulating the embarkation of the troops there was organized at Bremerhaven a board of embarkation, upon the senior officer of which was incumbent the chief conduct of the whole embarkation.

5. It was to be expected that effects and military stores of every kind would pour into the collecting stations in enormous quantities. It was therefore deemed expedient, in the interests of the railways and collecting stations, to regulate the arrival. This was systematized in such manner that each office which had charge of preparing military stores reported the readiness of a shipment by railway transport notice on Form VII of the Military Transport Regulations directly to the railway division of the general staff. The latter, by referring to the schedule of shipment, made some arrangement for

the transportation of the stores referred to—for instance, by simply ordering the shipment of the same by freight. This method was employed in connection with the reenforcement of troops which left Bremerhaven between August 31 and September 7, and also in connection with the additional supplies shipped from Hamburg. This prevented an undue accumulation of stores, since they arrived as needed. At the first transport of troops, for special reasons, the discussion of which is outside of the scope of this article, the decision as to the mode of railway transportation had to be left with the office at the point of departure.

The distribution of the troops was based on the annexed "Schedule for the embarkation of the East Asiatic expeditionary force," which, with slight changes, was applied also to the second expedition. The number of steamers required for the transportation was determined from the total number of first, second, and third class passengers to be embarked. In view of the long voyage through the Tropics—the hardships and fatigues of which were an entirely new experience for our soldiers—and of the necessity of the expeditionary force reaching its destination in the best possible physical condition, only 75 per cent of the normal number of passengers were quartered in the steerages, which proved a very wise measure.[1]

The distribution of the troops was attended with great difficulties, as it was imperative that the different units of troops, with all their personnel and matériel, should remain together, while the steamers were, of course, not built with a view to such a requirement. One steamer, for instance, had room for many troops, but had limited cabin accommodations; another, in accordance with the usual demands on her, had a surplus of the latter, but did not have enough steerage room; and again, a large freight steamer could accommodate comparatively few passengers.

It is not to be understood from the above that the steamship companies furnished steamers that were inferior or not suitable for the transportation of troops. On the contrary, the ships were excellent in themselves—better, probably, than had ever been employed for such purposes. But, owing to the fact that the ships were required immediately and in such large numbers, careful examination and selection were impossible. Those steamers had to be taken which happened to be at home or on their way there, and which the companies could best spare from the regular traffic. The natural result was that extensive changes had to be made; cabins, stairs, and refrigerating rooms had to be built; skylights and air-ports had to be cut, electric wires laid, steam-heating apparatus installed, etc., so that the demands upon the companies' working forces were very great. This experiment has demonstrated, however, that by such modifications any good steamer can be transformed into a serviceable troop transport.

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[1] As far as known, other nations have utilized the normal capacity of transports to the full extent. In the Spanish-American war the transports taking the Spanish troops to and from Cuba were even crowded to 25 per cent above their normal passenger capacities.

In working out the schedule of embarkation two contingencies had to be considered: Either the Chinese fleet had to be taken into account, in which case it was best for the transports to concentrate at Singapore, for instance, and proceed thence through Chinese waters under the protection of German warships; or, precluding the possibility of danger from the hostile fleet, each transport could proceed on its voyage independently. In the former case it was expedient to have the slowest ships sail first, so as to assemble the transport fleet as early as possible at the port of rendezvous. In the latter case it was best to have the fastest ships sail first, in order to reinforce, as soon as possible, our inadequate fighting forces in East Asia and to gain time for the tedious disembarkation at the port of destination.

As the situation of war, and especially the unquestionable superiority of the allied fleets in East Asia, rendered any interference with the movements of our transports improbable, three fast steamers were made the first group that sailed July 27, and which, hastening ahead of the other ships, formed a vanguard, so to speak. To this end, the following bodies of troops were assigned to the first group:

Staff of the first infantry brigade.

First regiment of infantry.

Staff and two squadrons of regiment of cavalry. (As the horses had been ordered from America and Australia and were to reach their destination, in part at least, before the troop transports, the early departure of these squadrons was especially desirable. Details to establish a depot for horses had been sent on ahead.)

Second division of regiment of field artillery.

One battery of heavy field howitzers. (The early arrival of these proved valuable in the storming of the Peitang forts.)

Telegraph division.

Field hospitals Nos. 1 to 4.

In the first group were also included the "Etappenkommandeur" (officer who has charge of everything connected with the supply trains and supply lines) and all the technical troops, who were embarked on the fastest steamer, so as to enable them to assist the navy in the work of disembarkation and to lend their aid in the preparations on shore, which were being carried on by an earlier detachment, consisting of 21 officers, surgeons, and superior officials, and 120 men, who had sailed from Genoa on July 24 on a German mail steamer.

The headquarters of the expeditionary force, whose early arrival on the scene of action was very desirable, was not able, for good reasons, to sail until August 2 with the third group. But arrangements had been made for the *Rhein*, a 13-knot steamer, to make the voyage in the shortest possible time, avoiding all delays not absolutely necessary.

Of the bureaus called into being for immediate cooperation in the embarkation, the collecting station at Bremen was the first to begin active work, namely, on July 12. It is not the intention to speak in detail of its organization, but merely to give an idea, in a few words, of its tasks as far as they were directly connected with the embarkation.

In the first place, all piece goods received had to be assorted and examined as to the packing and labeling. Articles improperly packed had to be repacked, and incorrect labels corrected.

Next, the goods had to be transferred to the lighters assigned to the different steamers (in which connection the military principles heretofore mentioned had to be observed), and had then to be shipped to Bremerhaven on schedule time.

An idea will be gained of the amount of work that had to be done when it is stated that between the 12th and the 30th of July 6,220,462 pounds of freight intended for the expeditionary force were received at the Weser station on 1,418 cars, and were disposed of.

In a similar manner the office of the station master at Bremerhaven had to receive the vehicles, ammunition, etc., arriving there, and convey them in the prescribed manner to the wharves alongside the transports. The disposition of the freight was rendered difficult by the fact that the available space had, under all circumstances, to be utilized to its full capacity in order to make it possible to store all the war supplies. It was, therefore, necessary to stow at once as much bulk freight as possible in the hold of the ship, leaving just enough space to stow the vehicles, effects, etc., belonging to the different bodies of troops and marked with the name of the respective ship. To determine, even approximately, the amount of space to be reserved for this purpose in each instance was impossible, as the soldiers themselves had many articles brought on board, such as mess and canteen stores and the like. As soon as it was ascertained, after stowing all the effects and stores of the troops, that there would be space left, it had to be filled with bulk freight, which it would have been so desirable to have had at the bottom. But in spite of all precautions about 35,314 cubic feet of reserve provisions were left behind when the first group of transports started.

As far as possible the effects and stores of the troops were conveyed alongside the steamers separated according to the division of troops, so that they could be taken on board in the desired order. But in some cases this measure was of no avail—as, for instance, when the cargo of a lighter could not all be stowed in the same compartment and part of it had to be stowed in another. The nautical requirements, which demanded, among other things, that heavy articles should be stowed as low down as possible in the ship and that vehicles be closely packed to secure them for sea, for which purpose boxes of provision were especially adapted, were frequently in conflict with military demands.

The whole work was rendered more difficult by the rainy weather prevailing and through the circumstance that most of the steamers arrived at Bremerhaven behind time. The original intention had been to send off the first detachment on August 1, and the steamship companies had made their arrangements accordingly. When the date of departure was changed to July 27, it was not possible to withdraw the ships from their schedule trips early enough and the time thus lost had to be made up by the most arduous work, without interruptions of any kind. For some of the steamers there remained but two days in which to unload their regular cargo, equip the ship as a transport, and reload. Nevertheless it was possible for the steamers, with one exception, to start promptly on schedule time, and the Lloyd, which in addition had to keep up its regular traffic. deserves the highest commendation for the performance.

The dispositions for the accommodation of the troops on the different steamers necessitated extensive alterations which the steamship companies had to make, as may be seen from the various requirements before mentioned. The steamers had to be utilized after the manner of barracks and the necessary preparations made accordingly. To this end several officers of the great general staff and a number of men were assigned as "Quartiermacher" (director of quarters), so to speak, to the embarkation board. All first and second class staterooms were assigned to officers according to rank and seniority, and labels with the names of the occupants were placed on the doors. All rooms used for special purposes, as storerooms, for instance, for officers' baggage and men's bags, or as water-closets, offices, cells, etc., were marked accordingly, and the steerages were subdivided, as far as possible, corresponding with the military divisions. Signs on the decks and stairways indicated to the troops the way to their quarters.

The embarkation of the troops, under the supervision of the respective general staff officers, was effected as follows: Immediately upon the arrival of a train, which stopped in the immediate vicinity of the respective transport steamer, the troops were formed in front of the railway cars and mustered. The officers were given short instructions and taken to their staterooms. The general staff officers, with the assistance of the sergeants and petty officers of the embarkation board, gave each of the soldiers quartered between decks a number which corresponded to one of the numbers with which the bunks, gun racks, and mess tables had been marked.

The soldiers were then marched aboard in squads, and temporarily put their baggage in the bunks and their guns in the gun racks. In the meantime, the officers' baggage and men's bags, as well as all war supplies which the troops had brought with them, were unloaded from the cars by the naval division charged with that work, and placed on the wharves in the prescribed order. Each man had then to find his bag and carry it aboard. The officers looked after their baggage and had it carried aboard and put away in their staterooms or baggage rooms, as the case might be. Finally, the remaining effects and stores were stowed. On an average, the embarkation of a battalion took from one to one and one-half hours.

Preparations for the routine duties on board during the voyage were confined mainly to the appointment of a transport leader (Transportführer) for each ship. He was given charge of all the printed regulations required for the voyage, such as the Naval Sanitary Regulations; besides which some information, calculated to facilitate his duties, was given him in writing, such as suggestions as to the daily routine, hints as to the organization of police details, special instructions concerning hygiene in the tropics, reports to be made in foreign countries, regulations concerning the dispatch of mail, etc.

Such hints were the more necessary as it had not been found practicable to assign a naval officer to each steamer. Only the staff of the commander in chief of the expeditionary force had a naval lieutenant at its disposal.

Some of the ships carried from 4 to 6 horses. In all, 30 horses were embarked for the purpose of testing, for the first time, whether they could stand such a long voyage through the tropics. As far as known, all the horses arrived in good condition. But this should not lead to the conclusion that the transportation of horses on a large scale for mounted troops is practicable.

It may safely be asserted that the measures taken for the transportation of the expeditionary force proved efficient. It is especially gratifying to note that during the whole voyage, covering forty-eight days, passing through the tropics in the hottest season of the year, the state of health of the soldiers was excellent. The following are the only losses to be deplored: Two men, of sunstroke (one of these belonged to the army staff outside of the troop transport proper, on board the mail steamer *Sachsen*); 1 man, of peritonitis; 1 man of inflammation of the brain; 1 man had his skull crushed by a falling wire cable; 2 men were drowned.

All of the troop transports arrived at Taku on schedule time, without any accidents, with the exception of the steamer *Strassburg*, which was delayed eleven days owing to insignificant injuries.

Schedule for the embarkation of the East Asiatic expeditionary corps.

No.	Steamer.	Capacity.			Formation.	Latest date for arrival of freight at Bremen.	Loading of ammunition and vehicles at Bremerhaven.	Latest date for arrival of troops at Bremerhaven.	Time of high tide.	Departure.	Speed in knots.	Space available for freight after embarkation of troops and vehicles.
		First class.	Second class.	Third class.								*Cubic feet.*
1	Batavia	109	48	2,138	Staff, first infantry brigade; first regiment of infantry; second division of regiment of field artillery; field hospitals Nos. 1 to 4.	July 21, a. m.	July 25–26	July 27, 10 a. m.	2.20 p. m.	Friday, July 27, 1 p. m., from outer anchorage of Imperial Harbor.	12	95,349
2	Halle	16	8	[1]488	One battery of heavy artillery of field army (howitzers); one ammunition column of same; telegraph division.	do	do	July 27, 9 a. m.	2.20 p. m.	Friday, July 27, 12 noon, from New Harbor.	11½	40,611
3	Dresden	48	20	925	Staff, regiment of cavalry; two squadrons of regiment of cavalry; pioneer battalion with steel-boat bridge train; railroad-building company with train column; "Etappenkommandeur" (see p. 427); clothing depot.	do	do	July 27, 10.30 a. m.	2.20 p. m.	Friday, July 27, 1.30 p. m., from Imperial Harbor.	13	8,829
4	Sardinia	25	10	484	Staff, regiment of field artillery; first division of regiment of field artillery; one light ammunition column.	July 24, a. m.	July 28–29	July 30, 12 noon.	4.10 p. m.	Monday, July 30, 3 p.m., from outer anchorage of Imperial Harbor.	11	38,845
5	Aachen	18	6	[2]489	Sanitary company; field-bakery column; one-half light field-howitzer ammunition column.	do	do	July 30, 11.30 a. m.	4.10 p. m.	Monday, July 30, 2.30 p. m., from New Harbor.	11½	44,143

[1] And 6 horses.

[2] And 5 horses.

Schedule for the embarkation of the East Asiatic expeditionary corps—Continued.

No.	Steamer.	Capacity.			Formation.	Latest date for arrival of freight at Bremen.	Loading of ammunition and vehicles at Bremerhaven.	Latest date for arrival of troops at Bremerhaven.	Time of high tide.	Departure.	Speed in knots.	Space available for freight after embarkation of troops and vehicles.
		First class.	Second class.	Third class.								
												Cubic feet.
6	Strassburg....	25	9	816	First battalion of second regiment of infantry...	July 25, a. m.	July 29–30	July 31, 1 p. m.	4.41 p. m..	Tuesday, July 31, 4 p. m., from New Harbor.	12	102,412
7	Rhein	135	43	[1]1,937	Headquarters of expeditionary corps; staff, second infantry brigade; third regiment of infantry; commander of train; second provision column; hospital reserve depot; military hospital personnel.	July 27, a. m.	July 31 to Aug. 1.	Aug. 8, 1.30 p. m.	5.46 p. m..	Thursday, Aug. 2, 4.30 p. m., from outer anchorage of Imperial Harbor.	13	81,223
8	Adria.........	16	10	579	Staff, division of ammunition column; infantry ammunition column; artillery ammunition column; field-howitzer ammunition column.	....do ...	.....do	Aug. 2, 2 p. m.	5.46 p. m..	Thursday, Aug. 2, 5 p.m., from Imperial Harbor.	11	95,349
9	Phœnicia.....	58	22	[2]1,718	Fourth regiment of infantry; first provision column; 1 captain and 6 privates of clothing depot; material of mountain battery.	July 29, a. m.	Aug. 2–3	Aug. 4, 2.30 p. m.	6.58 p. m..	Saturday, Aug. 4, 5.30 p. m., from outer anchorage of Imperial Harbor.	13	61,093
10	H. H. Meyer..	57	19	1,070	Staff, second regiment of infantry; second battalion of second regiment of infantry; 1 squadron of regiment of cavalry; magazine personnel; personnel for supervision of trains; supply-line ammunition column; personnel of hospital ship.	....do ...	.....do	Aug. 4, 3 p. m.	6.58 p. m..	Saturday, Aug. 4, 6 p.m., from Imperial Harbor.	13	10,594

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[1] And 5 horses.

[2] And 4 horses.

VIII.

NAVAL ESTIMATES OF FOREIGN POWERS FOR THE FISCAL YEAR OF 1901–1902.

By Lieutenant Orlo S. Knepper, United States Navy,
Staff Intelligence Officer.

The following estimates for the principal powers were taken from the official budgets, as passed by the various law-making bodies, and are, therefore, correct. For the minor powers the data were taken from press reports, but may be relied upon as being fairly accurate.

ENGLAND.

The total navy estimates for the fiscal year ending March 31, 1902, amount to £31,964,973. From this must be subtracted appropriations in aid amounting to £1,089,473, which leaves the total appropriation £30,875,500 ($149,755,620.75), a net increase over last year of £2,083,600 ($10,139,839.40).

The manning vote shows an increase of £233,000.

The shipbuilding vote shows an increase of £1,274,900.

The armaments vote is increased by £161,800.

The works vote is increased by £137,300.

The remaining votes show a net increase of £276,600.

The comparison in every case is with the original estimates of 1900–1901, plus the additional estimates voted in July, 1900.

PERSONNEL.

The personnel for 1900–1901 numbered 114,880. The estimates for 1901–1902 make it 118,625—an increase of 3,745. This increase is to be composed of the following:

Commissioned officers	151
Subordinate officers	48
Warrant officers	88
Seamen class men	1,150
Artisans	210
Engine-room ratings	500
Electricians (new rating)	100
Miscellaneous ratings	398
Boys (artisans training)	100
Royal marines	1,000
Total	3,745

NEW SHIPBUILDING PROGRAM.

The shipbuilding program as compared with last year's is as follows:

	1901–1902.	1900–1901.
Battleships	3	2
Armored cruisers	6	6
Cruisers, third class	2	2
Torpedo-boat destroyers	10	0
Torpedo boats	5	2
Sloops	2	2
Light-draught gunboats	0	2
Submarine boats	5	0
	33	16

Of the new ships authorized, 2 battleships, 1 armored cruiser, and 2 sloops will be built in the royal dockyards, and the rest by contract.

The total vote for new construction is £9,003,256 ($43,814,345.32), of which £8,465,406 ($41,196,898.30) will be devoted to pushing forward the ships already building, and to work on the submarine boats (commenced in 1900), and £537,850 ($2,617,447.02) to starting work on new ships.

FRANCE.

The total naval budget for 1901 amounts to 327,692,530 francs ($63,244,658.29). Of this, 85,166,298 francs ($16,437,095.61) are devoted to new construction.

SHIPBUILDING PROGRAM.

The following table shows the ships building and to be begun in 1901:

Class.	To be completed.		To be continued.		To be begun.		Total.
	Government.	Contract.	Government.	Contract.	Government.	Contract.	
Battleships	2	....	....	....	1	1	4
Armored cruisers	1	1	8	4	1	....	15
Cruiser, first class	1	....	....	....	....	....	1
Torpedo-boat destroyers	....	....	6	8	2	8	24
Submarine boats	7	....	....	....	8	....	15
Seagoing torpedo boats	....	7	....	....	....	....	7
Torpedo boats	4	7	2	8	....	11	32
Total	....	....	....	....	....	....	98

The following gives the contemplated dates of completion of this program:

1901:	
Battleships	2
Armored cruisers	2
Cruiser, first class	1
Destroyers	3
Dispatch boat	1
Submarines	5
Seagoing torpedo boats	7
Torpedo boats	12
1902:	
Armored cruisers	7
Destroyers	3
Submarines	7
Torpedo boats	15
1903:	
Armored cruisers	4
Destroyers	16
Submarines	3
Torpedo boats	5
1904:	
Armored cruiser	1
Destroyers	2
1905:	
Battleships	2
Armored cruiser	1

INCREASE IN PERSONNEL.

A scheme was submitted to the French Chamber in March, 1901, for an increase in the personnel, but has not as yet passed.

In the line down to the rank of commander the list remains the same, but 150 promotions are to be made from the list of lieutenants to the new rank of lieutenant-commander. The number of lieutenants, moreover, is to be raised from 754 to 870 and the sublieutenants and midshipmen from 599 to 700. In the engineering branch there were formerly 300 chief engineers, 100 of the first class and 200 of the second class. In the future there will be 30 chief engineers ranking with lieutenant-commanders, 170 engineers of the first class ranking with lieutenants, and 270 engineers of the second class ranking with sublieutenants. The increase will be effected gradually until it is complete in 1907.

On April 1, 1901, 20 additional submarines of about 70 tons displacement were authorized.

RUSSIA.

The total naval budget for 1901 amounts to 97,097,666 rubles ($50,005,297.99), an increase of 9,532,966 rubles ($4,909,477.49) over the budget for 1900.

Following are the items of the 1901 budget, with those of 1900 given for comparison:

	1900.	1901.
	Rubles.	*Rubles.*
Administration	2,275,329	2,349,020
Salaries and assistance	506,346	545,278
Educational	983,704	1,132,767
Medical establishments and services	1,045,294	1,203,777
Wages to officers, seamen, etc	4,751,436	5,392,547
Victualing	1,761,038	1,890,774
Clothing	2,367,662	2,881,869
Expenses in ships afloat	14,297,769	20,318,803
Hydrographic department	805,123	1,007,609
Hydrographic survey of the mouths of the Yenissei and Obi	54,700	54,700
Light-houses	275,000	300,000
Naval armament	8,696,039	11,965,107
Shipbuilding	23,060,426	17,805,439
Repairs of ships	6,266,886	7,797,676
Admiralty yards and workshops	4,689,245	5,822,669
Buildings and repairs	4,049,522	5,654,341
Traveling expenses and messages	790,500	840,000
Various expenses	1,435,533	1,637,634
Building of Port Imperator Alexander III	3,200,000	3,200,000
Improvement of Vladivostok	3,000,000	2,000,000
Improvement and fortification of Port Arthur	3,000,000	3,000,000
Expense of preparing next year's estimates	253,148	297,656
Total	87,584,700	97,097,666

The amount estimated for shipbuilding in 1899 was 34,062,537 rubles.

SHIPBUILDING PROGRAM.

The budget for 1901 authorizes the construction of 1 cruiser of 3,000 tons at the Baltic Works, 2 of 6,300 tons at Nicolaieff and Lazarieff, and 6 torpedo-boat destroyers of 350 tons.

There has been ordered at Kiel a transport of 12,000 tons displacement with a maximum speed of 18 knots, capable of steaming at reduced speed, with her own coal supply (800 tons), a distance of 10,000 miles, and at the same time transporting a cargo of 4,000 tons of coal. Also to be used as a training ship for machinists and firemen, for which purpose she carries Schultz, Belleville, Niclausse, and Yarrow boilers. She has all the auxiliary engines of a man-of-war.

GERMANY.

The German naval program, passed June 12, 1900, was fully given in last year's annual. This program is being vigorously pushed, and it is likely that it will be completed by 1908 instead of 1916. At least by that date the fleet will be completed, and then new ships will be built to replace old ones that are still serviceable.

The total amount of the budget for the present fiscal year is 196,734,172 marks ($46,822,732.94), of which 74,983,000 marks ($17,845,954) is devoted to shipbuilding and 25,603,000 marks ($6,093,514) to armament.

INCREASE IN PERSONNEL.

The personnel is to be increased in 1901 by—

Rear-admiral	1
Captains	3
Commanders or lieutenant-commanders	9
Lieutenants	12
Lieutenants, junior grade	24
Ensigns	16

SHIPBUILDING PROGRAM.

The following new ships are to be laid down this year:

Battleships "H" and "J" of 13,000 tons	2
Armored cruiser "C" of 8,870 tons	1
Small cruisers "G," "H," and "J," of 2,800 tons	3
Torpedo-boat destroyers of 350 tons	6

ITALY.

The total budget for the fiscal year of 1901–2 amounts to 122,816,555.85 lire ($23,703,595.28). Of this amount $4,709,200 is appropriated for increase of the navy, principally for the construction of new ships. The total budget is practically the same as last year, but the expenses of the navy are increased by 2,868,450.75 lire ($553,611). The sum of 10,000,000 lire ($1,930,000) is appropriated as bounty on a navigation premium on Italian merchant vessels.

This sum is considered by the press of Italy to be much too small, and an extended shipbuilding program is being vigorously advocated. In the meantime the Government seems to be undecided as to what type of ships to build. It has been decided to lay down two first-class battleships, one at Castellammare and one at Spezia.

JAPAN.

The total Japanese budget for the fiscal year ending March 31, 1902, amounts to $18,557,633.

The items of the budget are as follows:

Ordinary expenditures:	
1. Navy office	$92,234
2. Naval establishments, salaries, supplies, etc	9,988,271
Total ordinary expenditures	10,080,505

Extraordinary expenditures:

1. Arsenal	$220,750
2. Office buildings	37,000
3. Incidental construction and repair	20,392
4. Sending artificers abroad	16,186
5. Hydrographic survey	19,436
6. New constructions of ships, ordnance, and buildings	7,815,630
7. Shipbuilding materials, Kure naval station	50,000
8. Temporary civil engineer department	26,965
9. Gratuities	600
10. Alterations in Naval Engineer College	1,179
11. Charts and record	3,000
12. Extending Kure Arsenal	265,831
Total extraordinary expenditures	8,477,128

It is reported in the local press that the Government has decided to commence the third naval expansion scheme during the year commencing March 31, 1902. No details are as yet given.

AUSTRIA.

The total budget for 1901 amounts to 43,710,820 crowns ($8,873,296.46).

Some of the items of the budget are as follows: Shipbuilding, 14,250,000 crowns ($2,892,750); armament (gun and torpedo), 5,882,000 crowns ($1,194,046); pay, 6,017,550 crowns ($1,221,562.65); libraries, hospitals, naval academy, and schools, 483,730 crowns ($98,197.19); material, keeping ships in repair, and naval arsenals, 7,099,770 crowns ($1,441,253.31); pensions, 1,927,940 crowns ($391,371.82).

Ships building or proposed are—

Battleship of 10,000 tons	1
Battleships of 8,340 tons	2
Armored cruiser of 7,400 tons	1

DENMARK.

The total naval budget amounts to 6,851,449 crowns ($1,836,188), of which 5,164,469 crowns is for expenses of the navy proper, and 1,689,980 crowns for offices and institutions under the administration of the ministry of marine.

A battleship of the *Herluf Trolle* type (3,470 tons) is building.

SWEDEN.

The total budget of Sweden for 1901 amounts to 22,074,121 crowns ($5,915,864).

Some of the items of the budget are as follows:

	Crowns.
Personnel of the navy	3,711,987
Repairs and maintenance of ships	1,725,000
Equipment and maneuvers	1,231,900

	Crowns.
Pilot and life-saving service	1,500,409
Construction of warships	7,823,500
Reconstruction of *Svea*, *Göta*, and *Thule*	2,420,000
Reconstruction of *Thordön* and *Tirfing*	100,000
Ammunition for the navy	315,000
Target practice	15,000
Armament and fortification of Karlskrona and Farosund	825,000
Mine defense, Goteberg Harbor	628,145

NORWAY.

The total budget amounts to 4,485,000 crowns ($1,201,980), an increase of 28,000 crowns ($7,504) over the preceding year.

Of this amount, 800,000 crowns ($214,400) is for the construction of new ships. A 120-ton submarine of the *Holland* type has been ordered.

SPAIN.

The Spanish minister of marine has made a beginning with the reform in his department. Hitherto the too numerous personnel of the navy has swallowed almost the entire budget. The present minister intends to devote the 20,000,000 pesetas ($3,860,000) of the budget almost exclusively to the building of new ships and the improvement of those now in existence, and the personnel is to be reduced to what is absolutely indispensable. In order to carry this measure into effect, no new candidates are to be admitted to the naval schools proper. Other less important academies and schools, which are under control of the navy department, are to be closed entirely, and the marine infantry (corps of marines) is to be dissolved.

HOLLAND.

The total naval estimates for 1901 amount to 16,657,693.80 florins ($6,696,394.92).

The items of the budget are as follows:

	Florins.
Cost of management and administration	382,092.33
Matériel and naval establishment	7,182,195.00
Personnel	4,419,278.97
Pilotage, buoys, lights, hydrography	2,509,586.00
Pensions, etc	2,104,541.50
Unforeseen expenses	60,000.00
Total	16,657,693.80

The ten-years' program given in last year's Annual is still under discussion, but has not been passed.

The only new ships to be built are 3 torpedo boats of the *Ophir* class.

MEXICO.

It is reported that Mexico has authorized the construction of 8 gunboats of 1,000 tons displacement and 16 knots speed, and 2 torpedo boats.

TURKEY.

Turkey has contracted with the Cramps for a 3,000-ton cruiser of the *Denver* type. The speed will be greater than that of the *Denver* type, possibly 22 knots.

A contract has also been signed with a German firm for the reconstruction of the battleship *Assar-i-Tewfik*, but as yet no work has been done.

The Constantinople correspondent of the London *Times* is quoted as saying that the foreign engagements of the Porte for the purchase and renovation of warships and for naval and military artillery now amount to $11,679,600, while the treasury is absolutely empty and internal debts are increasing daily.

IX.

TABLE SHOWING NAVAL TONNAGE BUILT AND BUILDING FOR DIFFERENT CLASSES OF SHIPS OF THE SEVEN PRINCIPAL NAVAL POWERS, AND SOME GRAPHIC TABLES.

By Lieutenant Orlo S. Knepper, United States Navy,
Staff Intelligence Officer.

The table has been compiled principally from a British Admiralty return. It includes all vessels built or building on January 15, 1901, and under the latter head includes vessels not yet laid down, but for which money has been appropriated and which will be laid down in 1901.

The table does not give the total displacement of the various navies, as all gunboats, auxiliaries, etc., are omitted. Our converted merchantmen are all omitted. Antiquated vessels are also omitted, but 10 old British battleships, armed with muzzle-loading guns, are included, and 8 of our old smooth-bore monitors. With these exceptions, the only muzzle-loading guns included are on the Italian battleship *Duilio* (10,962 tons), which carries four 17.5-inch muzzle-loaders.

The 5 British submarines were not given in the return, as at that time their building was kept a secret.

France authorized 20 submarines on April 1, 1901, and these are included.

While the table is of no great practical value, figures of total displacement always being deceptive, it gives a fairly good idea of the trend of modern naval construction.

The graphic tables are designed to show, in the clearest manner possible, the comparative strength of the navies, with the commerce they have to protect and the seacoast they have to defend.

The displacement figures are taken from the preceding table, the value of exports from a British Parliamentary return, and the total miles of seacoast from data prepared by the United States Coast Survey.

The value of one year's exports by sea, including bullion and specie, is taken as the measure of commerce, and this seems fair, as the export trade is what is sought after. The value of British exports includes, of course, exports from all her colonies.

	England.		France.		Russia.		United States.		Germany.		Italy.		Japan.	
	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.
Battleships:		*Tons.*		*Tons.*		*Tons.*		*Tons.*		*Tons.*		*Tons.*		*Tons.*
Built	50	581,105	28	275,843	15	150,484	8	83,094	19	123,404	15	148,588	6	77,220
Building	16	229,900	5	62,455	10	130,270	10	133,800	10	116,770	6	70,568	1	15,200
Armored cruisers:														
Built	9	56,000	7	37,752	11	83,231	2	17,415	4	35,195	5	31,891	6	50,737
Building	20	226,400	15	148,260	1	7,800	9	109,500	3	26,390	1	7,294	1	9,750
Protected cruisers:														
Built	103	499,870	38	128,907	3	12,612	14	61,403	15	58,589	16	41,427	14	51,568
Building	1	24,960	2	13,493	11	60,640	6	21,000	7	18,200	......	....	3	4,400
Unprotected cruisers:														
Built	11	23,010	7	22,962	3	8,090	6	11,397	20	40,780	......	....	9	13,802
Building	......	....	......	....	......	....	......	....	......	....	......	....	......	....
Coast-defense vessels—armored:														
Built	10	38,900	14	43,331	14	42,873	15	43,934	11	12,001	......	....	4	10,280
Building	......	....	......	....	1	5,000	4	12,940	......	....	......	....	......	....
Special vessels:														
Built	2	13,020	1	5,994	5	5,280	1	929	3	4,026	......	....	1	4,120
Building	......	....	......	....	2	5,000	......	....	......	....	......	....	......	....
Torpedo vessels:														
Built	35	27,840	15	8,912	17	14,709	......	....	2	1,862	14	11,308	1	850
Building	......	....	......	....	......	....	......	....	......	....	......	....	......	....
Torpedo-boat destroyers:														
Built	89	28,314	9	2,700	10	2,890	3	860	12	4,025	3	923	11	3,229
Building	24	8,844	22	6,556	43	10,430	17	6,930	15	5,250	8	2,560	8	2,734
Torpedo boats:														
Built	95	7,380	235	16,408	171	9,507	20	2,337	140	11,990	163	8,148	38	3,894
Building	4	720	44	3,343	24	3,730	12	2,040	......	....	......	....	36	3,714

TABLE I.

Tons Displacement.
Battleships, Cruisers and Torpedo Craft.

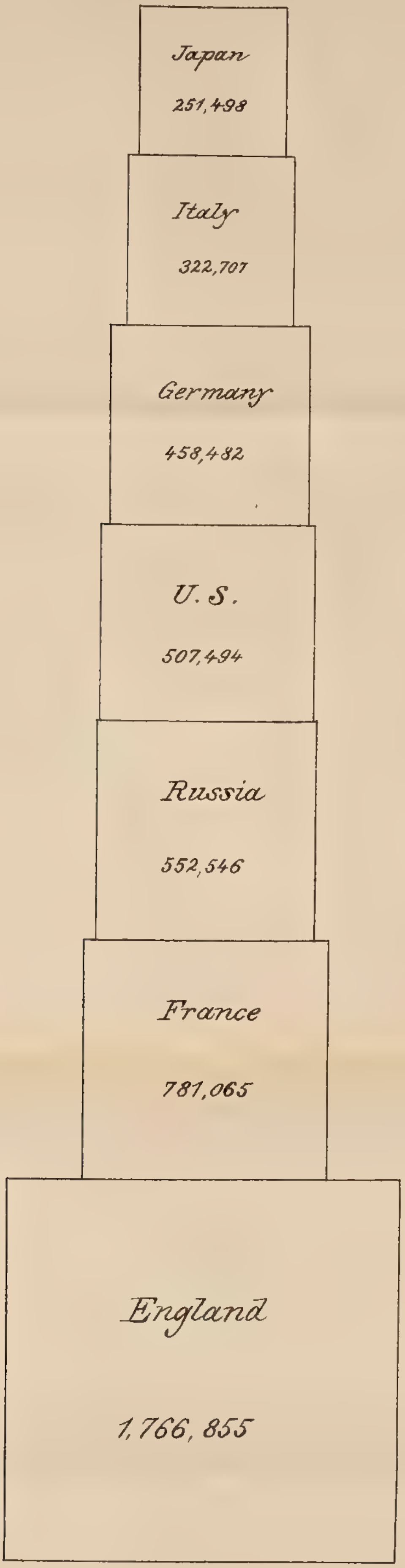


TABLE II.

Value of Exports by Sea for one Year, including Bullion and Specie (1899).

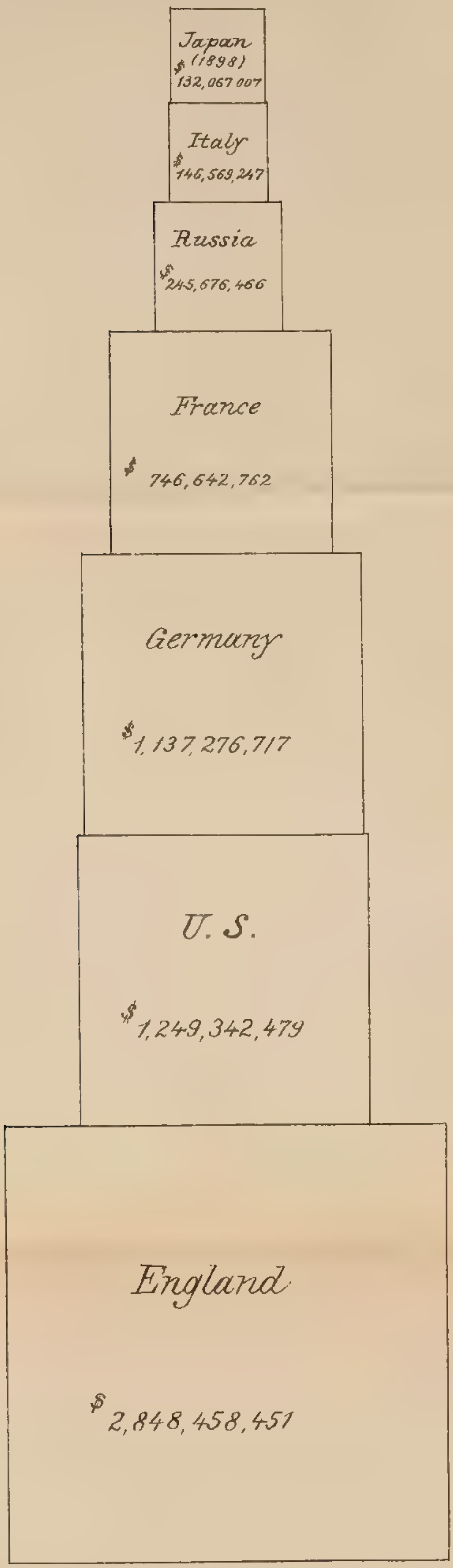


TABLE III.

Total Miles of Sea Coast, including all Dependencies or Colonial Possessions.

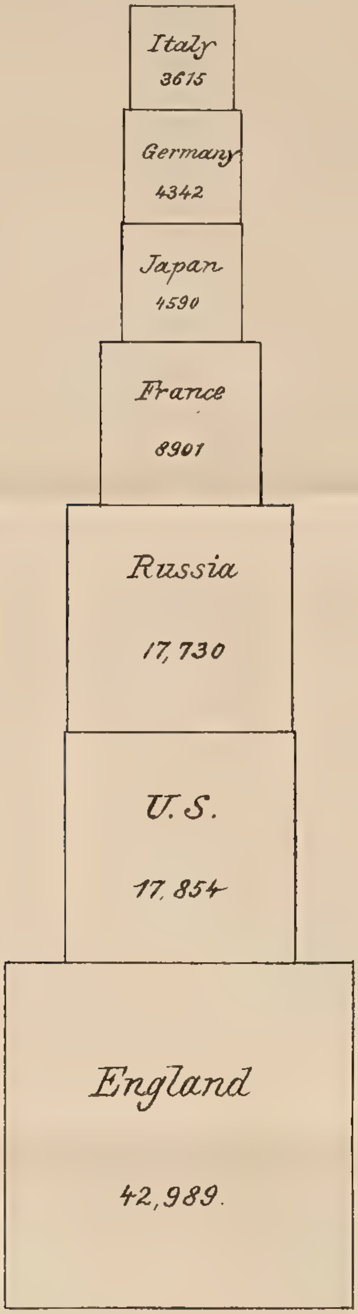


TABLE IV.

Value of Exports,
for each Ton of Naval Displacement.

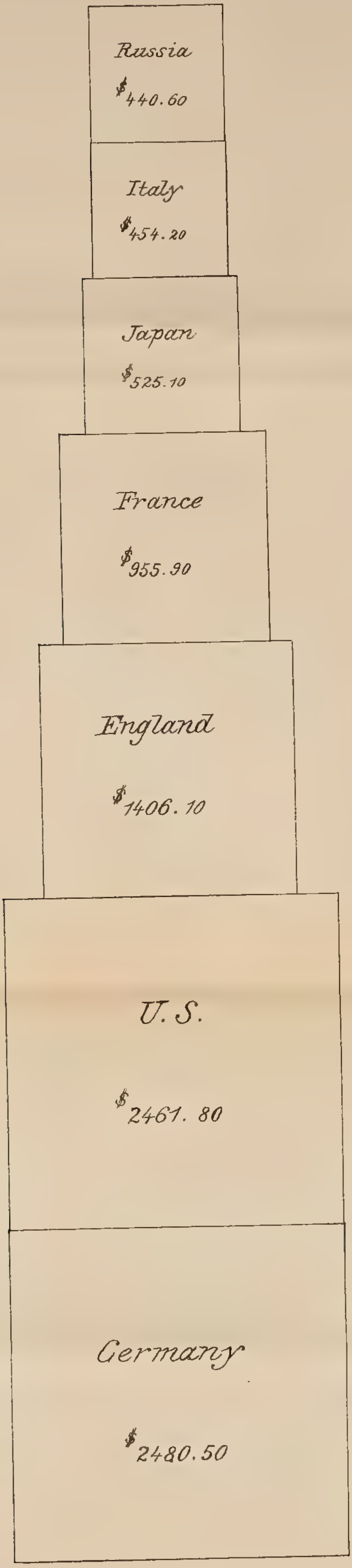
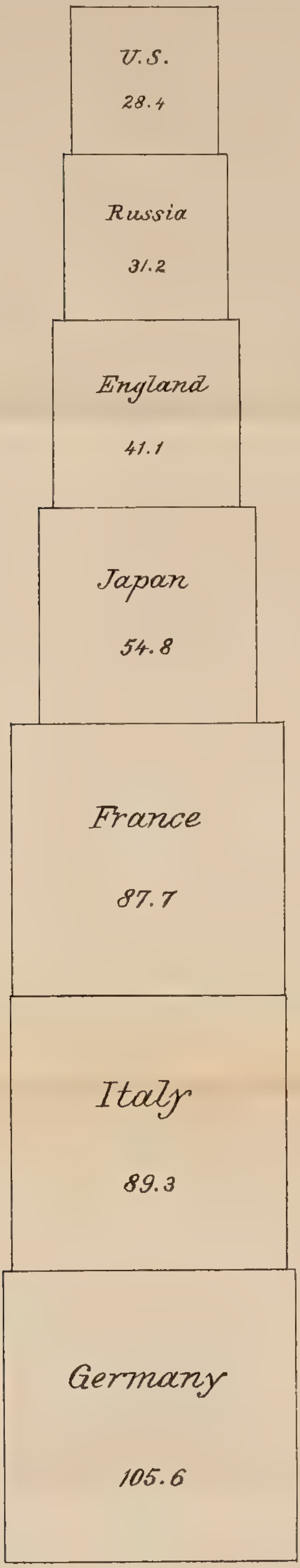


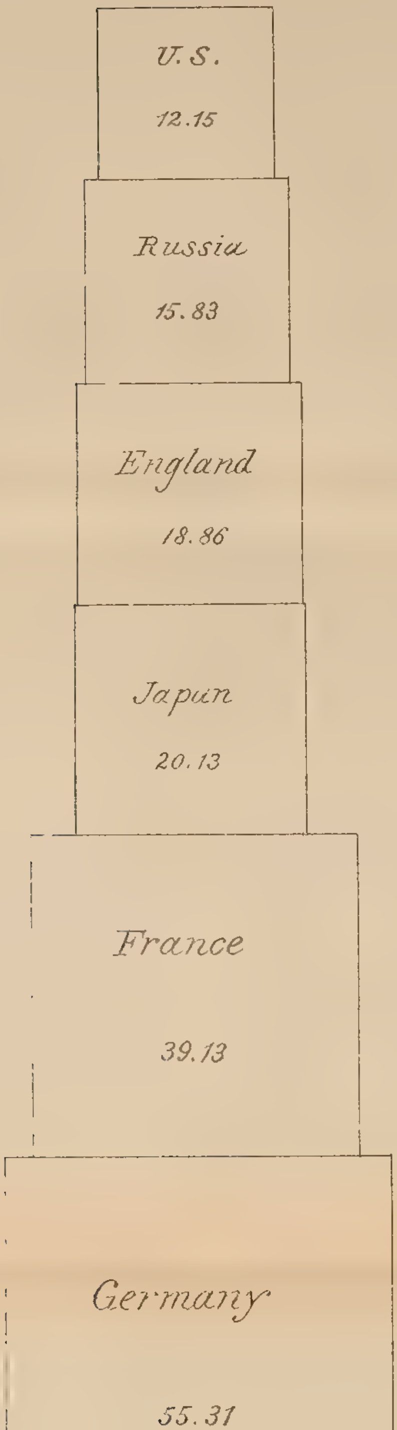
TABLE V.

Tons Displacement, for each Mile of Sea Coast.



TABLE

Tons Displacement of Ba
for each Mile



Submarines:																
Built	......	....	4	485	......	....	1	75	......	....	......	....	......	....		
Building	5	600	38	3,664	......	....	7	840	......	....	......	....	......	....		
Total tonnage																
Built	404	1,275,429	358	543,294	249	329,676	69	208,919	226	291,872	216	242,285	90	215,700		
Building	73	491,426	126	237,771	92	222,870	66	298,575	35	166,610	15	80,422	49	35,798		
Total tonnage	477	1,766,855	484	781,065	341	552,546	135	507,494	261	458,482	231	322,707	139	251,498		

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